DOCUMENT RESUME

ED 291 571	SE 048 903
TITLE	Communications and Computers in the 21st Century. Hearing before the Technology Policy Task Force of the Committee on Science, Space, and Technology House of Representatives, One Hundredth Congress, First Session.
INSTITUTION	Congress of the U.S., Washington, DC. House Committee on Science, Space and Technology.
REPORT NO	House-Comm-Pub-24
PUB DATE	25 Jun 87
NOTE	83p.
AVAILABLE FROM	Superintendent of Documents, Congressional Sales Office, U.S. Government Printing Office, Washington, DC 20402.
PUB TYPE	Legal/Legislative/Regulatory Materials (090)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	College Science; *Computers; Engineering Education; *Government Role; *Government School Relationship; Higher Education; *Manufacturing Industry; *Professional Associations; Research and Development; Research Universities; Science and Society; *Technology
IDENTIFIERS	*Congress 100th

ABSTRACT

Based upon the premise that manufacturing, communications, and computers are the key to productivity, this hearing before the Technology Policy Task Force was held to examine how the federal government interacts with universities, engineering research centers, professional associations, and private businesses in these areas. This document contains the testimony of four individuals involved in these fields. They were: (1) Dr. Richard Nelson, Professor of International Political Economics, Columbia University; (2) Dr. Lewis Branscomb, John F. Kennedy School of Government, Harvard University; (3) Larry Sumney, president, Semiconductor Research Committee; and (4) Lawrence C. Seifert, Vice President, Engineering, Manufacturing, and Production Planning, AT&T. (TW)

COMMUNICATIONS AND COMPUTERS IN THE 21ST CENTURY

HEARING

BEFORE THE

TECHNOLOGY POLICY TASK FORCE

OF THE

COMMITTEE ON

SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDREDTH CONGRESS

FIRST SESSION

JUNE 25, 1987

[No. 24]

Printed for the use of the
Committee on Science, Space, and Technology

U.S. GOVERNMENT PRINTING OFFICE

76-014 WASHINGTON : 1987

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

ROBERT A. ROE, New Jersey, *Chairman*

GEORGE E. BROWN, Jr., California
JAMES H. SCHEUER, New York
MARILYN LLOYD, Tennessee
DOUG WALGREN, Pennsylvania
DAN GLICKMAN, Kansas
HAROLD L. VOLKMER, Missouri
BILL NELSON, Florida
RALPH M. HALL, Texas
DAVE McCURDY, Oklahoma
NORMAN Y. MINETA, California
BUDDY MacKAY, Florida
TIM VALENTINE, North Carolina
ROBERT G. TORRICELLI, New Jersey
RICK BOUCHER, Virginia
TERRY BRUCE, Illinois
RICHARD H. STALLINGS, Idaho
BART GORDON, Tennessee**
JAMES A. TRAFICANT, Jr., Ohio
JIM CHAPMAN, Texas
LEE H. HAMILTON, Indiana
HENRY J. NOWAK, New York
CARL C. PERKINS, Kentucky
C. THOMAS McMILLEN, Maryland
DAVID E. PRICE, North Carolina
DAVID R. NAGLE, Iowa
JIMMY HAYES, Louisiana
DAVID E. SKAGGS, Colorado***

MANUEL LUJAN, Jr., New Mexico*
ROBERT S. WALKER, Pennsylvania
F. JAMES SENSENBRENNER, Jr., Wisconsin
CLAUDINE SCHNEIDER, Rhode Island
SHERWOOD L. BOEHLERT, New York
TOM LEWIS, Florida
DON RITTER, Pennsylvania
SID MORRISON, Washington
RON PACKARD, California
ROBERT C. SMITH, New Hampshire
PAUL B. HENRY, Michigan
HARRIS W. FAWELL, Illinois
D. FRENCH SLAUGHTER, Jr., Virginia
LAMAR SMITH, Texas
ERNEST L. KONNYU, California
JACK BUECHNER, Missouri
JOEL HEFLEY, Colorado
CONSTANCE A. MORELLA, Maryland

HAROLD P. HANSON, *Executive Director*
ROBERT C. KETCHAM, *General Counsel*
CAROLYN GREENFELD, *Chief Clerk*
R. THOMAS WEIMER, *Republican Staff Director*

TECHNOLOGY POLICY TASK FORCE

BUDDY MacKAY, Florida, *Chairman*

GEORGE E. BROWN, Jr., California
DOUG WALGREN, Pennsylvania
TIM VALENTINE, North Carolina
C. THOMAS McMILLEN, Maryland
DAVID E. PRICE, North Carolina
DAVID R. NAGLE, Iowa
JIMMY HAYES, Louisiana
DAVID E. SKAGGS, Colorado
ROBERT A. ROE, New Jersey****

RON PACKARD, California*
CLAUDINE SCHNEIDER, Rhode Island
TOM LEWIS, Florida
PAUL B. HENRY, Michigan
HARRIS W. FAWELL, Illinois
CONSTANCE A. MORELLA, Maryland
MANUEL LUJAN, Jr., New Mexico****

* Ranking Republican Member.
** Resigned February 19, 1987 (H. Res. 89).
*** Elected March 30, 1987 (H. Res. 133).
**** Ex-Officio voting member.

CONTENTS

WITNESSES

COMMUNICATIONS AND COMPUTERS IN THE 21ST CENTURY

THURSDAY, JUNE 25, 1987

House of Representatives,
Committee on Science, Space, and Technology,
Technology Policy Task Force,
Washington, DC.

The task force met, pursuant to notice, at 9:43 a.m., in room 2325, Rayburn House Office Building, the Honorable Buddy MacKay (chairman of the task force) presiding.

Staff Present: Dr. Kevin Kennedy, Mr. Ron Williams and Dr. Harlan L. Watson.

Also Present: Mr. Alan Magazine.

Mr. MacKay. Ladies and gentlemen, we will go ahead with our meeting although there are obviously some problems with the conflict of scheduling this morning. This is our second full hearing of this task force. I say this for our witnesses. We are attempting a different format from the normal committee hearing format.

We are trying to stress the fact that our primary interest is communication and not protocol so we are asking members of our advisory committee to join us here. We are also trying to utilize a setting which maximizes communications.

So I have advised our witnesses that I am going to attempt to keep the formal comments to an absolute minimum on our side of the table. We have asked them to summarize their testimony. In exchange for their restricting the amount of their opening comments, I have assured each of them they will have a chance for a closing comment at the end. At our last hearing, we found to our frustration that the real communication came in the last half hour instead of the first half hour.

This morning our witnesses are Dr. Richard Nelson, Professor of International Political Economics at Columbia University; Dr. Lewis Branscomb, John F. Kennedy School of Government at Harvard University; Mr. Larry Sumney, President of Semiconductor Research Corporation and recently appointed managing director of SEMATECH; and Mr. Lawrence Seifert, Vice President for Engineering, Manufacturing and Production Planning at AT&T.

We have one order of business to complete which is the approval of the agenda for this task force. It has been distributed to each of us and was held over from our previous meeting. Is there any objection to it?

[No response.]

If not, we are going to assume that it has been approved and for the record, that will be our assumption.

Our subject this morning is the roll of government in fostering the growth and application of technology. We believe that manufacturing, communications and computers are the key to productivity and we have asked this panel of witnesses to be with us today because we believe that you gentlemen are at the cutting edge in these areas.

What is the government doing that either helps or inhibits new communication technologies from reaching the market? At the same time, how can government assure without placing unjust restrictions or delays on the private sector, that new communication technologies will have lasting value for the public?

Today's hearing will examine how the Federal Government interacts with universities, engineering research centers, professional associations and private businesses in the areas of manufacturing, communications and computers.

We will begin with the testimony by the witnesses beginning from left to right, Dr. Nelson, Dr. Branscomb, Mr. Sumney and Mr. Seifert and then we will open the floor for discussion.

In the event that we have votes, let me say this. One other thing that was unanimously decided at the conclusion of the last hearing, in the event there are votes, we are not going to adjourn. We are going to go ahead. I will ask one member to go immediately when the bells ring and vote and come back and then I will go and that way, we will be able to continue. Last time we had three votes during the course of the hearing and that necessitated three half hour adjournments and it was very disruptive.

So we are going to try to develop some way to make sense around the ongoing legislative process. With those comments, if there are no opening statements on our side, we will go immediately to Dr. Richard Nelson. Dr. Nelson.

[The prepared statements of Hon. Buddy MacKay, Hon. George Brown, and Hon. Ron Packard follow:]

OPENING STATEMENT
OF THE
HON. BUDDY MACKAY (D-FL)
CHAIRMAN, TECHNOLOGY POLICY TASK FORCE

HEARING ON
COMMUNICATIONS AND COMPUTERS IN THE 21ST CENTURY

JUNE 25, 1987

GOOD MORNING LADIES AND GENTLEMEN. THIS MORNING WE WILL HEAR FROM DR. RICHARD NELSON, PROFESSOR OF INTERNATIONAL POLITICAL ECONOMICS AT COLUMBIA UNIVERSITY; DR. LEWIS BRANSCOMB, JOHN F. KENNEDY SCHOOL OF GOVERNMENT AT HARVARD UNIVERSITY; MR. LARRY SUMNEY, PRESIDENT, SEMICONDUCTOR RESEARCH COMMITTEE (AND RECENTLY APPOINTED MANAGING DIRECTOR OF SEMATECH); AND MR. LAWRENCE SIEFERT, VICE PRESIDENT, ENGINEERING, MANUFACTURING & PRODUCTION PLANNING AT AT&T.

BEFORE WE BEGIN HOWEVER, WE HAVE ONE ORDER OF BUSINESS TO COMPLETE; THAT IS, THE APPROVAL OF THE AGENDA WHICH IS BEFORE YOU. IF THERE IS NO DISCUSSION, I MOVE THAT THE AGENDA BE APPROVED AS WRITTEN; HEARING NO OBJECTIONS, SO ORDERED.

THIS MORNING WE WILL RECEIVE TESTIMONY AND DISCUSS THE SUBJECT OF THE GOVERNMENT'S ROLE IN FOSTERING THE GROWTH AND APPLICATION OF TECHNOLOGY.

WHAT IS OUR GOVERNMENT DOING THAT EITHER HELPS OR INHIBITS NEW COMMUNICATION TECHNOLOGIES FROM REACHING THE MARKET? AT THE SAME TIME, HOW CAN OUR GOVERNMENT ASSURE, WITHOUT PLACING UNJUST RESTRICTIONS OR DELAYS ON THE PRIVATE SECTOR, THAT NEW COMMUNICATION TECHNOLOGIES WILL HAVE LASTING VALUE FOR THE PUBLIC? TODAY'S HEARING WILL EXAMINE HOW THE FEDERAL GOVERNMENT INTERACTS WITH UNIVERSITIES, ENGINEERING RESEARCH CENTERS, PROFESSIONAL ASSOCIATIONS AND PRIVATE BUSINESSES IN THE AREAS OF MANUFACTURING, COMMUNICATIONS AND COMPUTERS.

AFTER REMARKS BY MY COLLEAGUE, RON PACKARD, THE TASK FORCE'S RANKING REPUBLICAN MEMBER, WE WILL BEGIN WITH BRIEF SUMMARIES BY EACH OF THE FOUR WITNESSES AND THEN I HOPE TO FOLLOW WITH A LIVELY DISCUSSION OF THE ISSUES.

MR. PACKARD.

OPENING REMARKS

TO

THE TECHNOLOGY POLICY TASK FORCE

Hearing on

"Communications and Computers in the 21st Century"

HON. GEORGE E. BROWN JR.

of California

June 25, 1987

Mr. Chairman, our decline in trade competitiveness is one of the great economic and political challenges facing our nation in the remaining years of the 20th century. In debating this issue, I believe we must move beyond facile solutions of trade protection and currency controls to address the underlying causes of our problems. For example, we have to find ways to raise our very low savings rate and to break down the isolation of economic and investment policies from science and technology policies.

Mr. Chairman, I am particularly pleased to see that we have as our first witness Professor Richard Nelson. Professor Nelson is one of the pioneering contributors to our understanding of the contribution of technology to economic growth. He is one of the few economists or scientists who have spanned the gulf between technology and economics. Thus he can provide us with unique insight into techniques and policies that might enable us to better co-ordinate technology policy with economic policy.

In recent months I have come to the conclusion that this problem of fusing technology with economics is central to our ability to promote industrial innovation. In remarks I gave to the Brookings Institution's recent conference on issues in science and technology policy for the 1980's I proposed:

* the modification of banking and investment regulations in order to create a national capital banking system under the aegis of the Federal Reserve System that will encourage public and private investment better tuned to our long-term economic development than is the case today.

* that scientists and technical experts be included as members of national and regional governing boards of the Federal Reserve System.

* mechanisms for the co-ordination of science policy and economic policy between the Office of Science and Technology Policy and the Council of Economic Advisors.

* a government chartered organization to expand secondary securities markets for investments in emerging industries.

* the creation of a National Retirement Account (NRA) with the power to make investments in both the public and private sector that would dramatically increase savings and capital for long-term investment. The NRA would be capitalized by surpluses in the Social Security OASDI Trust Funds that are expected to total $2.2 trillion thirty years from not.

* the repeal of Social Security payroll taxes when the returns from NRA investments are sufficient to provide for mandated Social Security OASDI benefits.

I would be very interested to learn the reaction of our witnesses to the proposals I have outlined here. I will provide the full text of my remarks to the Brookings conference to any witness willing to review them.

OPENING STATEMENT

HON. RON PACKARD (R-CA)

HEARING ON

COMMUNICATIONS AND COMPUTERS IN THE 21ST CENTURY

JUNE 25, 1987

I WOULD LIKE TO JOIN WITH YOU, MR. CHAIRMAN, IN WELCOMING OUR DISTINGUISED PANEL OF WITNESSES HERE TODAY.

STATE, FEDERAL, AND LOCAL GOVERNMENTS PLAY IMPORTANT ROLES IN ESTABLISHING THE GROUND RULES AND THE ENVIRONMENT IN WHICH MANUFACTURING, COMMUNICATIONS AND COMPUTER INDUSTRIES MUST OPERATE. THE TASK FORCE NEEDS TO BETTER UNDERSTAND THE IMPORTANT TRADE-OFFS AMONG THE VARIOUS GOVERNMENTAL REGULATORY, ANTITRUST, RESEARCH AND DEVELOPMENT, EDUCATIONAL, AND TAX POLICIES AND THEIR IMPACT ON THESE INDUSTRIES.

WE ARE ALSO VERY INTERESTED IN HEARING FROM OUR WITNESSES ABOUT HOW THEIR ORGANIZATIONS ARE WORKING TO ENHANCE THEIR OWN PRODUCTIVITY AND THE QUALITY OF THEIR PRODUCTS.

FINALLY, WE HOPE TO RECEIVE GUIDANCE AS TO THE ROLE THIS TASK FORCE CAN PLAY IN ESTABLISHING AN OPTIMUM TECHNOLOGY POLICY FOR THE NATION.

STATEMENT OF PROF. RICHARD NELSON, HENRY R. LUCE PROFESSOR OF INTERNATIONAL POLITICAL ECONOMICS, SCHOOL OF INTERNATIONAL PUBLIC AFFAIRS, COLUMBIA UNIVERSITY, NEW YORK, NY

Dr. NELSON. Thank you. It is a pleasure to be here. After reading the agenda that this committee set for itself, it seemed to me useful to comment briefly on three matters bearing on U.S. technology policy.

First, I thought it would be useful to introduce a bit of historical perspective on the nature of U.S. technological strengths over the last century and a half and the varied government policies that have supported these capabilities in different eras.

Second, I want to present tersely an argument that policies that are appropriate and feasible for one industry may be inappropriate or infeasible for another and finally, I want to draw from those observations some remarks that bear on the infrastructure issue which I gather is the current focus of attention of this committee.

Regarding history, I think it is worthwhile recognizing that the United States has been a significant technological player on the world scene for at least 150 years. While Great Britain clearly was the technological leader during the first Industrial Revolution, British and Continental observers of the United States were noticing American ingenuity and technological prowess in a number of fields well before the Civil War.

The Americans led the world in ship design then, for example. We pioneered the interchangeable parts manufacture. The middle and late 19th Century was widely recognized as a period during which American inventors were in the forefront of machinery invention, invention of a wide variety of other kinds of producer goods and consumer good advances in a wide variety of fields.

Now this early era was one during which mechanical savvy rather than advanced schooling was what mattered. Government roles were not particularly detailed or far sweeping during this first era.

The principal government contribution to American invention in this era probably was the prevention of the rise of guilds which were blocking technical advance on the Continent and hindering it even in England.

Now by the mid and late 19th Century, the scientific fields of chemistry and physics had become sufficiently powerful that training in these had become virtually essential if one were to be an effective inventor or problem solver in a wide variety of different technologies.

In Germany and the United States, the university systems accepted the basic and applied sciences as part of the curriculum. This did not happen in England nor in France. Thus, we as well as the Germans were able to provide industry with the trained scientists and engineers that were required for competence in the new chemical and electrical industries.

Many of these key U.S. universities were public and publicly funded. Between 1920 and the beginning of World War II, the United States established world leadership in the mass production

industries that accounted for the lion's share of industrial output then.

Our supply of college trained scientists and engineers was one part of the reason but the vast U.S. common market in an era where international trade was constrained, another important part. The size of the U.S. market and the traditional hostility toward cartelization which by then had been embodied in anti-trust legislation together assured a competition among technologically competent firms.

Then and now, this undoubtedly is a prerequisite for rapid technological progress. The era from the end of World War II until the middle 1970's saw the United States build on these earlier strengths and also add some others.

Prior to the war, while the U.S. university system had provided more than adequate training, it had certainly not been dominating as a locus of basic research. After the War, the government took on responsibility for the funding of the university basic research system in the United States and also significant government funds went into training of scientists and engineers.

Students trained under this improved and expanded system fueled the corporate R&D enterprise in that era where training in the basic sciences and technology were even more important than earlier to industrial R&D.

The U.S. also benefited during this period greatly from our massive defense research and development program in an era where several key technologies demanded by the military also had major civilian applications.

I could comment here extensively on the factors behind the erosion of the U.S. technological leadership that has occurred over the last two decades. The open world trading system that has diminished the special advantages possessed by U.S. firms living in the largest national market clearly is part of the story, the catching up by other nations with the United States regarding scientific and technical training another.

Then for a variety of reasons technology has become more international than ever before and spill over from the U.S. military programs has become less important but the issues here are too complex to dwell upon in this brief statement.

So let me turn to my second theme which is inter-industry differences. I want to highlight that theme by describing the differences and the roles played by government in agriculture, drugs and other health related products and electronics to pick three industries where the government has played a central role.

In agriculture, public funds and public institutions have played an essential role in applied as well as basic research, in technical education, dissemination of technical information as well as in providing credit, regulating prices and output, subsidizing exports, et cetera.

While the overall policy complex gets mixed grades, the support of R&D has yielded very high rates of return. This R&D support system has been from the beginning demanded and monitored politically by farmers.

While strong private enterprise existed or grew up to supply farmers with equipment or other inputs, division of labor has been worked out between public and private which has protected farmers and does not attack the interests of the industries in question.

In the field of pharmaceuticals and other health related fields, private companies established significant technical and scientific competence before the National Institutes of Health grew up. By in large, division of labor has been worked out wherein the government has supported work in the basic sciences and research on matters of sickness and health that eliminate possibilities for doing something about those problems but has stopped short of developing these.

The publicly supported part of the system also needs to be understood as connected with the training of doctors and health scientists, an objective supported by private industry and the medical profession.

In contrast, government R&D support in electronics has been heavily weighted toward the development of particular products and systems desired by the military. Support of basic and generic research has been justified largely in terms of how well it supports these objectives and support of higher education in these fields as well.

I make these contrasts to highlight that a discussion of a national technology policy that considers industry as a whole is likely to be superficial and not very illuminating. The kinds of government policies that are likely to be effective and politically acceptable undoubtedly differ significantly from industry to industry which brings me to my last topic, the topic of this session as I understand it, infrastructure.

It is not clear what range of activities or investments or institutions the infrastructure term is meant to encompass. Basic research for sure, education and training of various kinds, information dissemination, facilitation of cooperation in circumstances where this is deemed appropriate.

My belief is that infrastructure is a term used as an euphemism for the range of activities that government ought to support or ought to help industry cooperatively support. If so, I urge that this committee keep the following questions in mind.

First, what is special about the present times that call for significant reconsideration of what the government is doing? Second, what industry or complex of industries are we talking about and what are the appropriate governmental roles in those particular industries?

Mr. MacKay. Thank you, Professor Nelson. Dr. Branscomb.

STATEMENT OF DR. LEWIS BRANSCOMB, JOHN F. KENNEDY SCHOOL OF GOVERNMENT, HARVARD UNIVERSITY, CAMBRIDGE, MA

Dr. BRANSCOMB. Mr. Mackay, I thought since you urged us to stick to five minutes, I would rely upon the summary that is in my testimony, which you all have. I would like to address one simple question, which is; Why is this such a tough problem?

For years well-informed members of this Committee and people in the science and technology policy community have been trying to find a way to articulate the Federal government's proper role in efforts to improve the technological component of the nation's economic performance.

Any such policy, it seems to me, has to satisfy two conditions. First, it has to be technologically realistic; it must be able to address how firms in other countries compete successfully with ours without having either the fundamental science or the innovation capabilities for which this nation is justifiably renown.

In other words, it must recognize the pivotal importance of downstream science and engineering activities which have, in fact, provided others with a cost base and a quality level that has caught many of our companies by surprise.

The second requirement for such a policy is that it must avoid the valid objections of most people when they say "Federal industrial policy." That is, it must not put Federal agency officials in the position of second guessing business judgments that are best made in a highly decentralized competitive environment responsive to fast-changing competition and market conditions.

Now the difficulty in building consensus for the right policy lies in my opinion in two fallacies about the nature of the technological process, perhaps best called the "linear model fallacies," not new to any of you or any people in the science policy community but I think worth emphasizing.

This view, which I believe to be erroneous, holds that all innovations begin with fundamental research knowledge and follow a track through applied research, product design and development, manufacturing, engineering, testing and service.

This model further assumes that each level in that chain is progressively more application specific. Now a reasonable policy for government efforts to help the technical private industrial economy would be for the government to fund research in higher education in the most generally applicable knowledge and skills and avoid those that are the most application specific.

But the linear model fallacy leads to the widely held conclusion that the government should, therefore, confine its active support of science and engineering activities to fundamental research except in those areas of government responsibility for which it is the appropriate agency to do the application work, namely, military areas and others for which the government is in a procurement posture.

I submit that if we examine technical activities at both ends of the innovation process, basic research at one end and testing at the other, we will find in each a mixture of work, some of which is very narrow and application specific and some of which is very general and can be widely shared.

I believe that is true in basic science. I believe it is also true, perhaps a little less true but still true, in the downstream engineering activities.

Now let me just mention a couple of examples of downstream technologies that are the fruits of research but don't get the support they deserve from Federal science agencies precisely because they are downstream. They are viewed as so important to industry, people assume that they are, therefore, application specific and inappropriate for measured Federal attention. These examples are: automated design for manufacturability, manufacturing systems engineering, quality testing and process control, materials handling and distribution, information system support for balancing organizational control and efficiency with decentralized creative decision making.

These are all areas of knowledge and skill that are generated through research, that are transmitted through education. They need the best engineering minds in our universities to address them and they call for increased collaboration between universities and industry.

In answer to the excellent last question of Professor Nelson, I would say that what is different is that engineering has become scientific. It has become codified.

It is possible to put engineering problems in theoretical form and indeed to explore them with simulation and modeling. Therefore, these areas of downstream engineering activity not only depend more on an intellectual knowledge base, they are more critical in having the appropriate share of bright people address them.

But our Federal agency structure inhibits meaningful action; notwithstanding the efforts of the National Science Board for the last seven years or so and the welcome NSF initiatives to create Engineering Research Centers, which are aimed very much at the kinds of things I am talking about.

Unless some civil agency is prepared to accept the charge to take on these kinds of technical activities as a significant responsibility, the NSF will continue to be torn by pressures to take on all of these roles with resources that in my view are inadequate even with a doubled budget to cover that full spectrum of activity.

We must, I believe, find a way to transform the Department of Commerce into a Department capable of addressing industrial and technological issues and prepared to address these areas of our knowledge and skill infrastructure.

I believe it is these areas that are America's missing technical link to competitiveness. Thank you.

[The prepared statement of Dr. Lewis Branscomb follows:]

76-014 - 87 - 2

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

TECHNOLOGY POLICY TASK FORCE

Hearing June 25, 1987

Statement by Prof. Lewis M. Branscomb,
Director, Science, Technology and Public Policy Program,
John F. Kennedy School of Government
Harvard University, Cambridge MA 02138

This hearing focuses on a most important question: Should the federal government's technology policy attempt to address the linkages of federal investments in research, development and education to the technical underpinnings of U.S. private industry, or should these "downstream" engineering activities be left to market forces and private decisions?

As the Task Force's staff paper correctly observes, experts are almost unanimous in concluding that the technical dimensions of America's manufacturing industry competitiveness problems concern product design, production and quality control more than they concern either research and development or marketing, sales and finance. These matters are of real concern, and will be the focus of my testimony.

However, the public debate is not focussed on the federal role in this area because of the historic emphasis on and continuing concern about the nation's research and development capability.

U.S. R&D Capability

There is no doubt that research is the fountainhead of all technology as well as providing the knowledge with which to chose and apply technology. Americans must continue to build the national investment in research capability and in trained people, expert at the conduct of research. Let me cite four reasons why research must continue to be a focus of attention and public investment:

1) While recent federal budgets have permitted growth in some agency research programs - notably the NSF - the overall federal pattern is weak, primarily because of the failure of the Department of Defense to build its fundamental research base at the same time it extracts from the existing base with massive increases in applied research and development. It is neither possible nor practical that NSF and NIH should carry the entire burden of the research infrastructure investment. Just as each corporation funds its share of industrial research, so too federal agencies must each re-invest in the

knowledge base their programs draw from.

2) The federal investment in non-defense research and development, measured either in terms of research purchasing power or as a percentage of either the GNP or the federal budget, has been flat or declining since 1968, while all around us the world was changing and competitors were dramatically restructuring their economies around science-based industry strategies.

3) America's science and engineering education investments at all levels from K-12, colleges and universities, and especially the public support for student financial aid have failed to attract young Americans to careers in science and engineering in sufficient numbers to meet the country's needs. Post-graduate students in engineering continue to be mostly foreign citizens. Many of the brightest young people are discouraged from science and go into law or business. And many talented youngsters, especially young women and minorities are deprived of the educational background that could open opportunities in science for them.

4) The universities are struggling with serious financial problems and serious needs for their own infrastructure (equipment and new or refurbished facilities), just at the time when the President and the Congress have placed much of the responsibility on universities for linking the research, development and education resources to private industry. I question whether the universities can fulfill these expectations without more federal help than they are receiving.

Thus, before getting into the question of technology infrastructure, I want to urge the Congress not to neglect the unfinished job of building the research infrastructure. The President's proposal for a 5 year authorization for NSF and a doubling of NSF's budget is a good place to start.

This Hearing addresses two main categories of infrastructure: manufacturing and information systems. Let me address them in turn.

<u>Downstream Engineering Capabilities for Manufacturing</u>

Now let me turn to the equally pressing questions of what I call the "downstream" engineering capabilities that are required to translate the products of research into commercial products and services. I include here the skills and knowledge and tools for designing products to be manufacturable, for defining and controlling production processes, and for testing and assuring high quality and low cost in manufacturing, and finally in technologies for distribution and service.

Testimony 6-25-87
L.M. Branscomb

Two central difficulties impede progress in addressing these critical areas of engineering capability and help to explain why many U.S. firms have difficulty in cost and quality competition with firms in Japan or Germany, despite their excellent capacity for introducing innovations:

1) The closer federal programs come to areas of activity best understood by commercial industry, the weaker is the political consensus on the federal role, the more likely the program is viewed with suspicion as "industrial policy". This goes a long way toward explaining the weak role of the department of Commerce in technology -- for example the refusal of the Department in 1981 to implement the university-industry centers envisioned in the Stevenson Wydler Act.

2) Since 70 percent of the Federal R&D budget is obligated by the Department of Defense and other national security agencies, the emphasis in federally supported engineering projects has been on maximizing function with secondary regard for cost, for products in a low volume production. Commercial industry, by contrast, seeks to provide sufficient function at minimum cost in large volume production.

These differences are reflected in quite different engineering points of view, influences both the skills and the attitudes of young engineers trained in universities where defense R&D dominates faculty support. It contributes to the historic estrangement* of universities from middle-sized companies (those with less than $1 billion in annual revenue, most of which do little research but are very dependent on strong technology). The best and brightest young engineers want careers in research; few are willing to take jobs in factories.

3) The structure of the federal government reflects this reluctance of both federal agencies and many universities to address the contribution they might make to the downstream engineering performance of American industry.

NSF is making a valuable contribution through the Engineering Research Center program and perhaps through the new Science and Technology Centers as well, but their plate is full. They are already finding that the focus on technology transfer activities (such as the encouragement to university-industry collaboration) is generating nervous concern among basic research scientists who fear pressure on the

* While many engineering schools, such as RPI and Lehigh, do address commercial industry production technologies, the situation I describe is not uncharacteristic of the "great research universities". MIT is now engaged in a most welcome review of its engineering education from this perspective; it could become a leader in altering the current situation.

universities to expand their applied research at the expense of basic science.

This Committee and members of the Senate have introduced a number of measures aimed at strengthening the capability of the Department of Commerce to support needed educational and technological activities of importance to the nation's economic health. Something of this kind will be necessary if the needed federal programs can find suitable homes.

What is needed?

1) A major fellowship program is needed to attract American students of high academic achievement into manufacturing related engineering careers. Perhaps financed with matching contributions from private sources, such a program would not only fill a gap in educational support but would add prestige to this career area.

2) Funds are needed for universities to acquire technical equipment, revise and develop curriculum and generate work-study-research relationships with industry. IBM Corporation tested the desire and competence of the universities to use this help when it ran a competition for grants totalling $50 millions in cash and equipment for curriculum in manufacturing systems engineering. Some 48 schools implemented their plans, even though only a fraction of them actually received grants. All of them need support.

3) The congress should not only continue to extend the R&D tax credit and the new Basic Research credit, but should review what companies are doing under these incentives. Specifically, is the Basic Research credit attractive enough to provide a meaningful incentive? Is the wording of the program such that it prevents application to faculty work in manufacturing processes or systems engineering?

4) Many states have active programs to encourage the modernization of their local manufacturing industry, in the interest of preserving or attracting jobs. The federal agencies should be required to take these plans into account and coordinate with the states in trying to help the smaller and middle-sized companies that do not have the internal technical staffs to drive their modernization. States that come to the federal government asking for technical cooperation and assistance should be helped by a competent federal agency, or by the institutions the federal government supports.

Computers and Communications

This is a very large area of policy debate, and I can only touch on a few points that deserve federal attention. First, there is no doubt that the U.S. leads the world in the

imaginative and constructive use of computers and other information systems. This is an enormous asset, and is no in small measure both cause and result of the Nation's leadership in the worldwide computer industry. We must keep that advantage, which calls for:

1) Continued attention to quality education for all our citizens, incorporating computer and other educational technology in imaginative ways. Every citizen must be not only linguistically literate, but most should be computer literate as well.

2) At the professional level, the growth segment of the computer industry is software. It is also the most profitable and the segment in which the U.S. industry has the largest margin of superiority internationally. To protect this lead we need GATT coverage of services and software and protection of the intellectual property inherent in software products.

On the educational side, the federal government should give serious attention to encouraging post-graduate training in software engineering. It is not clear that this is an area within the research scope of interest of NSF. It is at too high an educational level for Department of Labor. But professional skills in software engineering are the gating factor, in my opinion, in the ability of most companies to expand their beneficial use of computers. Yet computers hold the key to productivity growth

3) Computer communications is the key to making a virtue out of the diversity born of the innovations encouraged by deregulation. Government should be sure it is not an impediment to the evolution of standards generated by the conjunction of interests of users and manufacturers. In point of fact there is a problem here: The Department of Defense continues to use protocols for digital packet switching (TCP-IP) which are different from those most accepted internationally (in the context of OSI and ISDN) and used commercially both here and abroad. The universities also make extensive use of TCP-IP, reflecting the influence of defense support of universities and the research contribution made by academic computer scientists to ARPANET and other defense network projects.

The National Bureau of Standards, on the other hand, works harmoniously with the manufacturers and users in industry not only to advance voluntary technical standards for OSI but also some application-specific standards such as MAP, in which General Motors plays a leading role. NBS is serving the correct role in behalf of the federal government. The Defense Department should be urged to bring its standards into harmony with commercial ones, which will also facilitate defense utilization of readily available commercial products.

Testimony 6-25-87
L.M. Branscomb

Summary

University - industry cooperation, as accomplished in NSF's programs and envisioned in the amended Stevenson-Wydler Act, are the best way to assure mutual stimulation and effective diffusion of knowledge between the federal investment in R&D and research - intensive companies. These should be encouraged, along with the traditional modes of support for academic science in an expanded budget for NSF.

The NSF cannot alone cover all of the research and education requirements of the technology infrastructure. The federal government needs a Department prepared and missioned to establish research investment programs aimed at the "downstream" engineering capabilities so essential to cost and quality competitiveness in trade. The Department of Commerce, perhaps appropriately renamed and remissioned, is probably the appropriate vehicle.

Government should make its investments in research, development and engineering pursuant to a strategy to enhance not only the government's own missions but the task of enhancing the strength of American industry for the public benefit. The "mission-oriented" agencies should be encouraged to expand their investments in fundamental research from this point of view.

This will require a more coherent policy balancing both economic and defense security purposes. Most especially it requires examination of the extent to which not only technology selection but education, industrial standards and other elements of infrastructure are responsive to commercial as well as defense requirements.

A strong education system in which the private sector takes a part in partnership with government is the cornerstone of that infrastructure. The downstream engineering activities of the industrial and commercial firms deserve special attention.

The private, voluntary standards system serves best the needs of efficiency, innovation and trade. However government has an important role to play through the research and technical participation of the National Bureau of Standards, and the willingness of other agencies, especially Defense, to accommodate their standards strategy to the larger economic interests of the country.

The States have been actively pursuing industrial development strategies of their own, and they need to be able to plan and work more harmoniously with the major federal R&D agencies to be sure their economic goals are enhanced by the federal activities in the state. This will call for more effective coordination and communication. A National Conference of

Testimony 6-25-87
L.M. Branscomb

States on Science and Technology Development might be sponsored by a federal agency such as NSF or NBS, with invited participation from the private sector to work out such arrangements. NBS has good experience with this mode of federal-state relationship in the fields of weights and measures and of building codes. The NGA might be a suitable institution to launch such a project.

Mr. MACKAY. Thank you. That is fascinating. Mr. Sumney.

STATEMENT OF LARRY SUMNEY, PRESIDENT, SEMICONDUCTOR RESEARCH CORP., RESEARCH TRIANGLE PARK, NC

Mr. SUMNEY. Mr. Chairman and members of the Committee, I am President of the Semiconductor Research Corporation based in the Research Triangle Park in North Carolina. We were funded about five years ago by the Semiconductor Industry Association as an industry-sponsored cooperative effort to conduct generic research in semiconductors.

I am serving also as managing director of SEMATECH, an industry consortium which has been initiated to reverse the erosion of the U.S. leadership position in semiconductor manufacturing.

I see many parallels between these two organizations in concept, in structure, in desired results and both the SRC and SEMATECH are directly relevant to the issue your Committee is addressing today, that is, how to ensure a cohesive national technology policy. I appreciate the opportunity to appear here today.

During the past ten years, American industry has come under increasing competition in pressure from foreign producers. Japan has mounted a concerted effort to promote its knowledge-intensive industries, an effort which features a close working relationship between government, industry and a coordinated application of policy measures to achieve long run strategic objectives.

As a result of these trends, we in the United States are re-examining many aspects of our approaches. Nowhere has this been more true than in microelectronics.

The U.S. semiconductor industry has a long tradition of extreme individualism and entrepreneurship. However, the semiconductor industry was one of the several strategic industrial sectors in which the Japanese government sought to achieve preeminence and by the mid 1970's, U.S. semiconductor firms recognized that they indeed confronted a formidable competitive challenge which could not be met by individual companies acting alone, no matter how innovative and how efficient they might be.

U.S. semiconductor producers concluded that in order to confront such a challenge directly, they needed to engage in a greater degree of collaboration and to work more closely with the U.S. government.

One of the first manifestations of this new spirit of cooperation was the formation of the SRC, which was created in 1982. Its principal objective was to fund basic microelectronics-related R&D in the university system in this country reflecting the fact that a decreasing amount of university research effort was being placed on fundamental R&D for industrial use.

While the SRC was formed to address the need for increased basic microelectronics research, SEMATECH has been formed to address the current vulnerability of the U. S. semiconductor industry in the area of the manufacturing of semiconductors.

Traditionally U.S. semiconductor firms have relied on the manufacture of certain high volume, high complexity devices known as technology drivers. These are used to develop the production proc-

esses necessary to remain competitive in semiconductor manufacturing as a whole.

In the face of foreign dumping of these product areas, however, many U.S. firms have had to abandon the manufacture of technology drivers with the result that they risk losing overall competitiveness in semiconductor manufacturing.

Moreover, the contraction of the U.S. position in high volume product areas has reduced the demand base for U.S. upstream suppliers of semiconductor manufacturing equipment and materials, who themselves confront a major foreign competitive challenge.

These upstream firms must remain viable if the U.S. semiconductor device manufacturers are not to become dependent on foreign sources for the advanced tools and materials which they will need in order to remain competitive.

SEMATECH, like the SRC, constitutes an important addition to the U.S. microelectronics infrastructure. Today, semiconductors are the basic ingredient of our economy. They touch every aspect of our lives. We cannot successfully manufacture other products, whether they be steel or stereos, ball bearings or bricks, without their use in the manufacturing, inventory and distribution process.

Our traditional industries, textiles, shoes, furniture and others, depend on this emerging industry for their future and our national defense is so closely tied to the force multiplier concept that semiconductors provide that the Defense Science Board has called a direct threat to the technological superiority deemed essential to U.S. defense systems.

The industry has agreed to raise half of the required $250 million dollar cost of the SEMATECH effort over a five year time frame. We believe that this industry, deemed critical to both our national economy and our national defense and willing to provide half the cost of a major technology effort, should be met at least halfway with government R&D support.

The SEMATECH mission very succinctly stated is to reverse the erosion of U.S. leadership position in manufacturing technology. Its objectives are to develop future generation semiconductor manufacturing processes, materials, tools and test equipment, prove and demonstrate them, and then transfer that knowledge which is the real product of SEMATECH to member companies.

SEMATECH will take research results coming out of the SRC and translate them directly into reality. It will be done generically rather than on a company-by-company basis which is much more costly and results in inefficient duplication of effort. The results coming out of SEMATECH will then be diffused industrywide.

SEMATECH will sponsor research activity to complement its development efforts. The SEMATECH operating plan calls for the SRC to provide the interface between SEMATECH and the research community with which the SRC already has begun to establish a very close working relationship.

This includes not only the universities but our national laboratories, government research entities and the independent research efforts in semiconductor technology such as those funded by state governments.

As a part of this effort, I am chairing a steering group examining the potential for a National Laboratories Initiative in semiconduc-

tors. In its research role, SRC will perform assigned research tasks for SEMATECH, create a knowledge base in areas of future manufacturing development and address issues associated with education and with training.

SRC will develop a five year research plan to complement SEMATECH's needs and its schedules. It will place and monitor research contracts and transfer research results to SEMATECH. It will coordinate and integrate its research with that performed by government agencies, and it will address the progress in relevant research made by competitors. Each of these support functions is important to the success of the SEMATECH mission.

Virtually every industrialized and developing nation which has sought to accelerate the development of a national capability in microelectronics has utilized the R&D consortium funded both by government and industry as a principal vehicle.

Such entities eliminate duplication in R&D, speed up development, and most importantly ensure a wider diffusion of research results throughout industry. SEMATECH is intended to secure all of these benefits for the U.S. industry. However, it will differ from many foreign consortia in one respect. It will encourage, rather than restrict, participation of small companies.

SEMATECH will give such firms access to R&D results far greater than they could ever achieve through their own efforts and in so doing, will help smaller innovative firms, which have always been an important U.S. asset to remain viable contenders.

The United States government pursues many policies and supports many programs which have an actual or potential impact on U.S. competitiveness in microelectronics, but results from these have never been applied in a very coherent fashion.

The SRC and SEMATECH are both initiatives which are designed to coordinate and integrate existing company, university and government efforts in the areas of basic research and manufacturing R&D respectively.

While these are important initiatives, they are only part of what is needed, a larger response to the challenge confronting the U.S. microelectronics industry.

In order to ultimately meet that challenge successfully, we need to coordinate all of our national programs more closely in order to make the best uses of the limited resources which are available such as our foreign competitors are doing.

The SRC has proposed the formation of an advisory group patterned after the highly successful National Advisory Committee on Aeronautics.

Congressman Valentine and others have introduced legislation which would form such a committee and this indepenuent, blue-ribbon committee would monitor the competitiveness of the U.S. semiconductor technology base, determine technical areas where the U.S. semiconductor technology is deficient, identify new or emerging semiconductor technologies that will affect our competitiveness, develop R&D strategies and tactics and recommend appropriate actions that support the semiconductor strategy.

A response to the leadership challenge through such a mechanism I believe is essential to an effective national response to our overall competitiveness problem.

Our nation's future economic status is firmly wedded to leadership in the high technology industries that depend on semiconductors. Our national defense is tied to the availability of leading-edge semiconductor devices. Our cooperative efforts in other areas have met with considerable success.

In agriculture, we have created a strong infrastructure that includes the agricultural extension service, agricultural research in places like Beltsville, and our land grant colleges and universities.

To assure U.S. leadership, to assure U.S. future security and welfare, a strong infrastructure must be established in U.S. microelectronics. Existing components of that infrastructure include the SRC, the universities, industrial laboratories and government and national laboratories.

Two additions to the infrastructure have been proposed, a National Advisory Committee on Semiconductors to provide overall leadership and direction and SEMATECH to cooperatively provide essential development of semiconductor manufacturing know-how. Both of these elements are essential and they are needed now.

Thank you.

[The prepared statement of Mr. Larry Sumney follows:]

Before the

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

WASHINGTON, D.C.

TESTIMONY OF

LARRY W. SUMNEY

ON BEHALF OF THE

SEMICONDUCTOR RESEARCH CORPORATION

June 25, 1987

Mr. Chairman and Members of the Committee, my name is Larry W. Sumney. I am President of the Semiconductor Research Corporation, based in the Research Triangle Park, North Carolina. SRC was begun five years ago by the Semiconductor Industry Association as an industry-sponsored cooperative effort to conduct generic semiconductor research. I am also serving as Managing Director of SEMATECH, an industry consortium which has been initiated to reverse the erosion of the U.S. leadership position in semiconductor manufacturing. There are many parallels between those two organizations in concept, structure, and desired results, and both the SRC and SEMATECH are directly relevant to the issue your Committee is addressing -- that is, how to ensure a cohesive national technology policy. I appreciate the opportunity to appear before you today.

Until very recently, most Americans tended to think of industrial "competition" largely in domestic terms, as a contest waged among U.S. companies in which the most highly competitive firms would prevail. The proper role of government was seen primarily as a neutral arbiter of this competition, intervening only for the limited purpose of ensuring that competitors adhered to the rules. Our science infrastructure -- the research universities' government laboratories, and the DOE National Laboratories -- were not usually thought of as playing a central or even a significant role in marketplace competition among private companies. Their role was seen as educating the young, pushing back the

frontiers of science, and making the fruits of their research available to everyone.

During the past ten years, however, American industries have come under increasing competitive pressure from foreign producers. Japan has mounted a concerted effort to promote its "knowledge-intensive" industries, an effort which features a close working relationship between government and industry, and coordinated application of policy measures to achieve long run strategic objectives. The Japanese effort has been spectacularly successful in some areas, such as microelectronics, new materials and optical communications. Japan's market gains in the high technology have been achieved at the expense of U.S. firms -- in 1986, the U.S. for the first time ran a net deficit in high technology products. A number of other nations -- Korea, Brazil, and some European countries -- are now seeking to emulate Japan's example using many of the same promotional methods to promote their own knowledge-intensive industries. As a result of these trends we have been forced to re-examine many aspects of our own laissez-faire approach. Nowhere has this been more true than in microelectronics.

Joint U.S. Industry Activities In Microelectronics

The U.S. semiconductor industry has a long tradition of extreme individualism and entrepreneurship. However, the semiconductor industry was one of several strategic industrial sectors in which the Japanese government sought to

achieve preeminence, and by the mid-1970s U.S. semiconductor firms recognized that they confronted a formidable competitive challenge which could not be met by individual companies acting alone, no matter how innovative and efficient they might be. The Japanese government was organizing and financing major joint industry-government R&D projects and providing a variety of other forms of assistance, including home market protection (until 1975), de facto exemption from Japan's Antimonopoly Law, R&D assistance from government laboratories (including the excellent research facilities of the Nippon Telephone and Telegraph Company ("NTT")). U.S. semiconductor producers concluded that in order to confront such a challenge directly, they needed to engage in a greater degree of collaboration, and to work more closely with the U.S. Government.

One of the first manifestations of this new spirit of cooperation was the formation of the SRC, which was created in 1982 to undertake a cooperative, generic research mission for the semiconductor industry. Its principal objective was to fund basic microelectronics-related R&D in the universities -- reflecting the fact that a decreasing amount of university research effort was being placed on fundamental R&D for industry use. The SRC's membership has now grown to 35, including a chapter member that is an association of 33 small equipment and materials suppliers. The SRC funds R&D at over 40 universities at an annual level of approximately $20 million; over 600 graduate students and several hundred

faculty members have been associated with the SRC program. In 1986, three U.S. Government agencies became participants in the SRC pursuant to a Memorandum of Understanding with the National Science Foundation. The SRC is a highly successful addition to the infrastructure of the U.S. semiconductor industry.

While the SRC was formed to address the need for increased basic microelectronics research, SEMATECH has been formed to address the current vulnerability of the U.S. semiconductor industry in the area of semiconductor manufacturing. Traditionally, U.S. semiconductor firms have relied on the manufacture of certain high-volume, high-complexity devices known as "technology drivers" -- DRAMs, SRAMs and EPROMs -- to develop the production processes necessary to remain competitive in semiconductor manufacturing as a whole. In the face of foreign dumping in these product areas, however, many U.S. firms have abandoned the manufacture of technology drivers, with the result that they risk losing overall competitiveness in semiconductor manufacturing. Moreover, the contraction of the U.S. position in the high volume product areas has reduced the demand base for U.S. "upstream" suppliers of semiconductor manufacturing equipment and materials, who themselves confront a major foreign competitive challenge. These "upstream" firms must remain viable if the U.S. semiconductor device manufacturers are not to become dependent on foreign sources for the advanced tools and materials which they need in order to

remain competitive. SEMATECH, like the SRC, constitutes an important addition to the U.S. microelectronics infrastructure. Today, semiconductors are the basic ingredient of our economy. They touch every aspect of our lives. We cannot successfully manufacture other products -- steel or stereos, ball bearings or bricks -- without their use in the manufacturing, inventory and distribution process. Our traditional industries -- textiles, shoes, furniture, and others -- depend on this emerging industry for their future. Our national defense is so closely tied to the "force multiplier" effect that semiconductors provide that the Defense Science Board has called the industry's plight a "direct threat to the technological superiority deemed essential to U.S. defense systems."

The industry has agreed to raise half of the required $250 million annual cost of the SEMATECH effort. We believe that this industry -- deemed critical to both our national economy and our national defense and willing to provide half the cost of a major technology effort -- should be met at the halfway point with government support.

The SEMATECH Mission

The SEMATECH mission is to reverse the erosion of the U.S. leadership position in manufacturing technology. Its objectives are to develop future generation semiconductor manufacturing processes, materials, tools and text equipment, prove and demonstrate them, and transfer that knowledge to member companies. SEMATECH will take research

results coming out of SRC and translate them into reality. It will be done generically, rather than company-by-company in a costly and inefficient duplication of effort, and the results will be diffused industrywide.

To this end, SEMATECH will be developing a detailed plan for each process module in the device manufacturing sequence. In addition, it will be focusing on the development of the manufacturing systems that will provide the highest degree of control for the manufacturing sequences and for the development of strong interfaces between the process, the equipment, and the designs. Following the development of the process modules, SEMATECH will integrate them and demonstrate their performance to agreed upon specifications in a limited production environment. A major task of SEMATECH is to build strong bridges between its development efforts and the industry to assure continuous flow of the knowledge acquired in development to the industry for application to both commercial and defense production.

SEMATECH will sponsor research activity to complement its development efforts. The SEMATECH operating plan calls for the SRC to provide the interface between SEMATECH and the research community with which the SRC already has established a working relationship. This includes not only our universities but also the national laboratories, other government research entities, and independent research

efforts in semiconductor technology such as those funded by state governments.

As a part of this effort, I am chairing a steering group examining the potential for a National Laboratories Initiative in semiconductors. The National Labs conduct a substantial amount of microelectronics-related R&D of tremendous potential value to U.S. industry, but to date there has been little close collaboration between the labs and U.S. companies. Two workshops have been held -- one here in Washington at the National Academy of Sciences and one at Sandia National Laboratory, and I feel the results achieved so far are very promising.

In its research role, SRC will perform assigned research tasks for SEMATECH, create a knowledge base in areas of future manufacturing development, and address issues associated with education and training. SRC will develop a five-year research plan to complement SEMATECH's needs and schedules. It will place and monitor research contracts and transfer research results to SEMATECH. It will coordinate and integrate its research with that performed by government agencies, and it will assess the progress in relevant research made by competitors. Each of these support functions is important to the success of SEMATECH. SRC will, in addition, provide SEMATECH with a data transfer and communications system to assure the integration of geographically dispersed activities and aid in the development of technology transfer methodologies for the new consortium.

The Merits of the Consortium Approach

Virtually every industrialized and developing nation which has sought to accelerate the development of a national capability in microelectronics has utilized the R&D consortium (funded by Government and industry) as a principal promotional vehicle. Such entities eliminate duplicative R&D, speed up development, and most importantly, ensure a wider diffusion of research results throughout industry. SEMATECH will secure all of these benefits for the U.S. industry. However, it will differ from many foreign consortia in one key respect -- SEMATECH will encourage, rather than restrict, participation of small companies.

The Japanese joint R&D projects in microelectronics have generally been closed to all but the largest Japanese electronics firms. SEMATECH, by contrast, has a dues structure based on percent of sales which will permit participation by small firms, and has developed a special arrangement which will encourage participation by the numerous small and medium sized enterprises which comprise the semiconductor manufacturing equipment and materials industry. SEMATECH will give these firms access to R&D results far greater than they could ever achieve through their own efforts -- and in so doing, will help smaller innovative firms, which are an important U.S. asset, to remain viable competitors.

A National Strategy

The United States Government pursues many policies and supports many programs which have an actual or potential impact on U.S. competitiveness in microelectronics, but these have never been applied in a coherent fashion. The SRC and SEMATECH are both initiatives which are designed to coordinate and integrate existing company, university and government efforts in the areas of basic research and manufacturing R&D, respectively. While these are important initiatives, they are only part of a larger response to the challenge confronting the U.S. microelectronics industry.

In order to ultimately meet that challenge successfully, we need to coordinate all of our national programs more closely in order to make the best uses of the limited resources which are available -- as our foreign competitors are doing. The SRC has proposed the formation of an advisory group patterned after the highly successful National Advisory Committee on Aeronautics, whose fostering of industry-government cooperation has provided the U.S. with over seven decades of leadership in Aviation. Congressman Valentine and others have introduced legislation which would form a National Advisory Committee on Semiconductors (NACS). This independent, blue-ribbon Committee would:

- monitor the competitiveness of the U.S. semiconductor technology base;
- determine technical areas where U.S. semiconductor technology is deficient relative to international competition;

- identify new or emerging semiconductor technologies that will affect the identify new or emerging semiconductor technologies that will affect national defense and/or U.S. competitiveness;

- develop R&D strategies, tactics and plans whose execution will assure U.S. semiconductor competitiveness, and

- recommend appropriate actions that support the semiconductor strategy.

A response to the leadership challenge through such a mechanism is an essential to an effective national response.

It is not envisioned that NACS be merely another study group or task force. Its charge is to devise and promulgate a national semiconductor strategy that addresses not only technical considerations but also the broad issues associated with industry structure and strategy, economic impacts, market and product factors, and national security.

In NACS, the U.S. can find the reliable, credible guidance to use its resources most effectively. We believe that NACS, with qualified leaders from government, industry, research and finance and with the resources needed to understand and analyze the complex technological, economic and national security issues involved, will result in a substantial improvement in the $3 billion invested in semiconductor R&D in the U.S. each year. This is like getting a $1 billion effort free of charge.

CONCLUSION

Our nation's future economic status is firmly wedded to leadership in the high technology industries that depend upon semiconductors. Our national defense is tied to the availability of leading-edge semiconductor devices. The problems we face are of the highest importance; they require national leadership and national solutions if we are to secure our economic competitiveness and our defense preparedness. In a National Semiconductor Strategy, both SEMATECH and the SRC are cooperative models with important roles associated with semiconductor competitiveness. The integration of these cooperative activities and the application of the results of past investments are keys to a successful national strategy.

The U.S. has been slow to recognize that wars fought in the economic arena are just as important as in the military arena, and the consequences of losing may be as equally severe. Other nations have directed resources to the economic wars in greater abundance and with greater effectiveness that has the U.S., and we are losing the once enviable position of being the world leader in high technology with serious consequences to our national security and economic status.

Our cooperative efforts in other areas have met with considerable success. In agriculture, we have created a strong infrastructure that includes the agricultural

extension service, agricultural research in places like Beltsville, and our great land grant colleges and universities. In aviation, NASA and its predecessor, the National Advisory Committee on Aeronautics, have led in the application of wind tunnels and supercomputers to aircrft design, and have fostered aviation technology for over 70 years. These infrastructures created by the government but providing a mechanism for industry-government cooperation have been key elements in the success of the U.S. in these areas. Similar mechanisms are required for those industries that will define the status of this country in the next century.

The U.S. microelectronics technology base is of critical importance to both national security and the economy. Its competitive position is threatened by foreign competition that has been developed with the assistance and through the leadership of the governments. The present trends are most important. In the last five years, the U.S. position in this technology has deteriorated rapidly.

To assure U.S. leadership, to assure U.S. future security and welfare, a strong infrastructure must be established in U.S. microelectronics. Existing components of that infrastructure include the SRC, the universities, industry laboratories, and government/national laboratories. Two additions to the infrastructure have been proposed, a National Advisory Committee on Semiconductors to provide leadership and direction and SEMATECH to cooperatively provide essential development of semiconductor manufacturing

know-how. Both of these elements are essential and needed now.

Mr. MacKay. Thank you very much. Mr. Seifert.

STATEMENT OF LAURENCE C. SEIFERT, VICE PRESIDENT, ENGINEERING, MANUFACTURING, AND PRODUCTION PLANNING, AT&T, BERKELEY HEIGHTS, NJ

Mr. Seifert. Thank you very much. It is a pleasure to be invited here. I am going to couch my remarks by first saying that I view myself as a manufacturing engineer and have spent most of the last ten years in overhauling American factories and applying technology to manufacturing.

I will try to give you a status of where we think we are in AT&T and the industry and what we think is the kind of help that we could use from government. First, let me say that we have experience with work forces in other countries and we believe the American work force in manufacturing is as good as any in the world. Other countries are coming up but that is not a problem. It is highly trained and highly motivated.

Second, we have a very strong technology base. We have some weaknesses in semiconductors because of initiatives in other countries and I think Mr. Sumney explained that very well but we do have a strength in software which is generally far superior to anything else in any other country.

In my opinion, we need to do three things to maintain a strong base of manufacturing in the United States. First, we need to maintain and strengthen our technology base. Many other countries are working on their technology and we have to keep up and keep ahead.

Second, our problem has been the application of this technology across our factories and that is the area we need to focus on.

Last, it is getting very expensive to overhaul and upgrade and apply all of this technology in factories and we believe we need free access to other markets to give us the base to afford that application of technology.

In AT&T as we look at what we are going to do with our manufacturing, we no longer consider manufacturing an industry in and of itself. It is part of the delivery process by which we apply technology to our customers' problems and it has been a mind set change for us to think of that as a delivery process and not an industry.

Therefore, all of our systems are intended to integrate right from product development through distribution.

Now I have a few remarks about the application of technology. We have spent a lot of time and a lot of money trying to apply technology in manufacturing and we have had some lessons, some of them very positive and some of them very hard.

Our priorities go as follows and I think Dr. Branscomb covered the manufacturing systems engineering very well. The key we have found in manufacturing is to overhaul our manufacturing systems in a way that would do the job differently. There is a lot of waste. There has been a lot of poor quality. We waste a lot of time as well as material.

The application of computer tools and software technology to the manufacturing engineering job has given us the most leverage. We

have actually been able to overhaul U.S. factories and make them competitive without the application of a lot of hard automation.

Second, factories are places where there is an awful lot of information flowing around and we have concentrated the application of computer technology to our factories. We deal with an awful lot of sophisticated ordering systems, billing systems, product configuration software, and that software is giving us a lot of leverage in doing the job much faster.

Last, as it relates to physical automation, we don't believe the key is automation where we directly replace people with robots, or that kind of automation. The key to robotics and that kind of technology is to do things that people can't do which we call suprahuman processing which by the way is a technology that has led us into the semiconductor business.

So we have concentrated our physical automation on doing things that people can't do. Where do we go from here? Certainly we need to continually upgrade our education systems. We have been encouraged that although over the years the colleges have neglected manufacturing in their programs, recently in the last five years, we have seen a lot more in the way of manufacturing programs in our universities. Also we could use some help from the business schools where the programs seem to be aimed at short term results.

Also, we need to improve the perception of manufacturing. We don't tell most of our children to go into manufacturing and if it is a national priority, we have to perceive it as an important activity.

What can the Government do directly? Clearly, we need to maintain the research base, especially our strength in software which we think is key to the future of manufacturing. We have to regain the leadership position in semiconductors. As it relates to computers and communications equipment, function is moving onto circuits and our future is not in assembly, it is in semiconductors.

Last, we could use some incentives. The permanent R&D tax credit which is in House Bill 1957 would be helpful. As I mentioned, it is very expensive for us to go through and overhaul all of our operations and apply technology.

We could also use some help in our factory renewals. I don't have a solution but some enlightened tax or depreciation policies relative to overhauling factories would be very, very useful. Remember in this country, we have to prove in our projects based on short term financial goals.

With that, I will end.

[The prepared statement of Mr. Laurence C. Seifert follows:]

STATEMENT OF

LAURENCE C. SEIFERT

Vice President of Engineering, Manufacturing
and Production Planning

AT&T

on
"INFRASTRUCTURES FOR THE DEVELOPMENT OF MANUFACTURING,
COMMUNICATIONS AND COMPUTER TECHNOLOGIES"

Before the
U. S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
TECHNOLOGY POLICY TASK FORCE

June 25, 1987

STATEMENT OF LAURENCE C. SEIFERT

My name is Laurence C. Seifert. I'm Vice President of Engineering, Manufacturing and Production Planning for AT&T. My responsibilities include AT&T's Engineering Research Center and its Manufacturing Development Center, as well as planning for AT&T's manufacturing productivity improvement programs.

AT&T has recognized the need for and actively pursued research and development in the manufacturing technologies at least since the establishment of its Engineering Research Center at Princeton, New Jersey in 1958. Our research at the Center ranges from advanced automation and robotics, to laser applications in manufacturing, to optical fiber processes, to electronic testing, statistical analysis and computer-aided manufacture. Our extensive program of manufacturing research and development at the Center over nearly 30 years has resulted in significant advances in manufacturing process technology and has enhanced AT&T's ability to produce high quality, cost-effective products.

The Manufacturing Development Center was formed in 1984 to provide a production facilities systems integration and replication capability. Major activities to date include production of manufacturing work stations, employing microprocessing, machine vision and robotics, which are connectable to computer integrated manufacturing software systems.

The past few years have been a particularly difficult time for the manufacturing segment of American industry. The literature is replete with articles discussing the causes underlying our apparent difficulties, and stressing the need to reshape and apply our technology resources in ways to revive our former U. S. manufacturing excellence. Growing numbers of companies are dedicating an increasing portion of their capital and R&D resources to renewing domestic manufacturing capabilities, with the firm conviction that this is the path to achieving and maintaining a strategic competitive advantage in the U. S. and international marketplace.

The AT&T research and development community, too, has refocused and intensified its efforts and resources aimed at improving AT&T's manufacturing operations. Now, in addition to the Engineering Research and Manufacturing Development Centers just mentioned, experienced AT&T Bell Laboratories systems engineering and software development groups are supporting applications of computer integrated manufacturing technology.

I would like to discuss today the course we've set for ourselves, what we've learned from our manufacturing productivity improvement programs and opportunities we see for furthering productivity gains. I would like, then, to suggest a set of needs and opportunities which we believe would further productivity gains throughout the domestic manufacturing community.

I recently delivered a paper on AT&T's manufacturing productivity programs at a meeting of the National Academy of Engineering. (The papers presented at the meeting will be published by the Academy.) The underlying observation I made then, and which I'll repeat here, is that the current

capabilities of our technology, our engineers and work force and the tools that are available to support us are more than sufficient to meet our goals. We must strengthen our lead in developing new technology, particularly software technology; but more technology, though always useful to have, is not the complete answer. The challenge is to incent and support the application of what we have more widely across U. S. manufacturing operations. We must significantly improve our ability to rapidly and effectively convert this technology into products and services. And we must accept the fact that our marketplace is worldwide and find ways to deal with the different laws and customs (and sometimes protectionism) of other countries. I'm pleased to see the efforts of this Task Force directed to these difficult challenges.

The key to a new industrial infrastructure is, in my opinion, integration of the various systems and functions into a single product realization process. A major stumbling block has been the mind-set that treats manufacturing as a stand-alone business or profit center within the overall business enterprise. As such, many in the industry have tended to measure manufacturing performance with such traditional financial indicators as plant turnover, plant utilization, and the like.

What we have to understand better for the future is that the vehicle for providing products and services to our customers is a combination of our manufacturing functions as well as our distribution systems and their underlying technologies. Consequently, industry must look to new measurement indicators for manufacturing performance -- indicators such as throughput, reaction time to market volume changes and effectiveness of new product introduction procedures.

As I mentioned before, I believe U. S. industry currently has the technological capabilities to achieve this integrated approach. Our past and current emphasis has tended to be on national programs for individual and joint academic and industrial research national research -- for example, through Engineering Research Centers. These have been and continue to be very worthwhile programs aimed at providing specific new technology for U. S. industry. However, more emphasis in the future must be placed on understanding why industry's existing technological capabilities have not been more widely deployed in its manufacturing operations. We must find the incentives and support that will encourage deployment of new and existing capabilities.

Our recent efforts at AT&T toward integrating manufacturing functions and distribution systems have taught us -- through our successes as well as through our failures -- that it is not the technology, even the exceedingly valuable software technology, that makes the real difference in our factories and our distribution channels. The differences come from improvements in the processes themselves brought about by integration. Quality and simplicity have been the cornerstones of our manufacturing productivity improvement programs, emphasizing reduction of waste and management of time. Key factors have been (1) the commitment of all involved personnel and management to the integration process and (2) the design and implementation of total integrated manufacturing systems and their linkages with other systems.

Based upon our experiences we've established a useful methodology for productivity improvement programs, wh' ', is depicted in Attachment A. The

first step, and a crucial one, is to redesign and re-engineer the processes before attempting to apply information automation or physical automation. We call this discipline manufacturing systems engineering. The concept of systems engineering at AT&T traces back to Alexander Graham Bell and is a discipline that has served us well over the years in our telecommunications network design and development.

Today we're applying systems engineering principles and process design and engineering tools to manufacturing. Although the principles are well-founded in the past, what's new is the tools that are possible with today's computing technology. These tools allow us to characterize, simulate and predict performance of our process designs during the design process rather than after we've deployed capital facilities. The resulting benefits of design for manufacturability come from simplifying our systems, improving yields and reducing the cost of quality.

The next step is information mechanization, sometimes referred to as computer integrated manufacturing. Modern manufacturing is highly information-intensive. Many attempts have been made at applying computer technology to mechanize information flows in manufacturing, and to embed process design principles and procedural disciplines in operations. Mechanization equals integration plus automation, and we've found the major benefits come from the integration component. Customized information systems for each operation can be too expensive. What's needed, and what we've been developing and deploying at AT&T, is a set of information systems that are modular and use an open systems software architecture. Combinations can be individually configured to meet the requirements of various production

processes, while also providing users with some design space for their unique needs.

The program has been quite successful in mechanizing information flows, and we're now in the process of embedding real-time versions of engineering and quality analysis tools in the systems. True real-time process control is an opportunity that we can now exploit through advances in microcomputing technology. This puts a whole new set of capabilities in the hands of local engineering and operating personnel and potentially results in their running processes at levels of efficiency never before achieved.

The third step is to provide physical automation for facilitating product flow or increasing labor productivity only <u>after</u> we're satisfied with our product and information system designs. Physical automation should be applied first where there is little choice but to use machinery, where the level of discipline, control metrology and/or feedback goes beyond what humans are capable of doing manually -- so-called suprahuman processing. A subsequent application of physical automation is to provide better discipline and control over the operational flow of the process. And, finally, after all other priorities are satisfied, we should carefully consider the use of machines for increasing labor productivity.

We've had a number of significant successes in AT&T which have proven to us the value of first applying systems engineering disciplines to manufacturing projects, then following up with information mechanization (integration plus automation), and lastly deploying physical automation. The capabilities are available within our existing engineering disciplines and

tools. I believe their widespread use would yield substantial improvement in U. S. manufacturing.

The failure to fully exploit these opportunities for further productivity gains in U. S. manufacturing may arise, in part, from inadequate training and motivation of our engineers. We need to deal with prevailing perceptions of manufacturing work as a less then desirable career. We must find ways to encourage our best and brightest graduates (technical and business) to pursue careers in manufacturing engineering curricula and centers for studying business techniques.

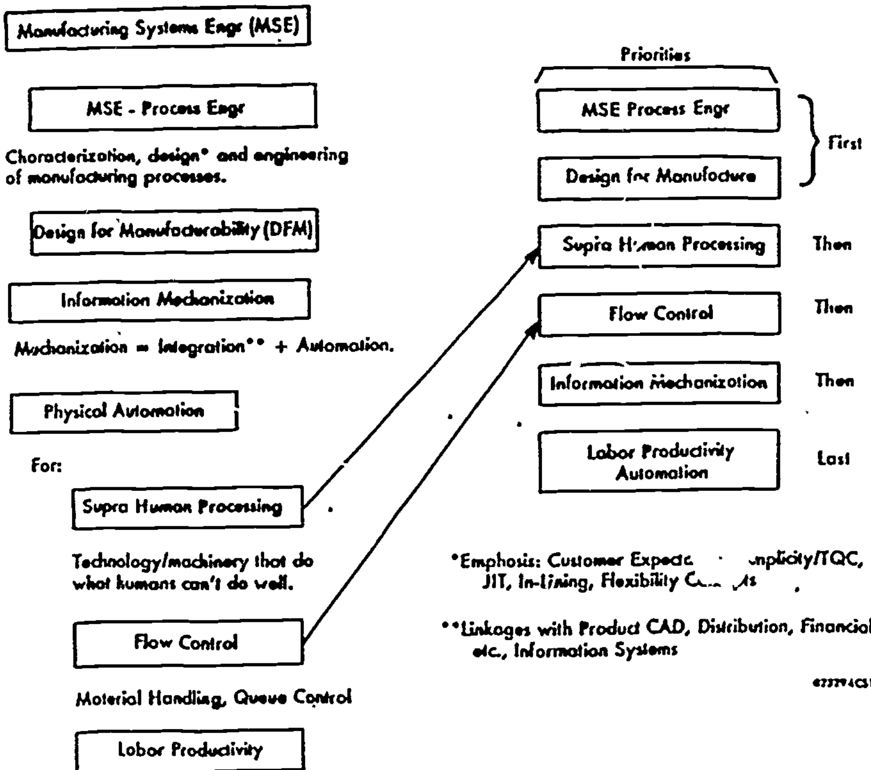
For the future -- and we're almost there as more and more technology is deployed in industry -- our manufacturing and distribution operations will be increasingly dominated by technology-skilled workers. A typical worker at the more advanced manufacturing operations today needs special advanced training just to deal with the computer technology and complex machinery being used. U. S. industry currently incurs a disproportionately large cost, compared to its major international competitors, in the training of entry-level workers. Our nation must intensify its efforts to provide programs at the high school and junior college level (perhaps even at the grade school level) to train people in the knowledge and skills needed to operate this ever more technologically-complex environment.

Although existing technology provides ample room for productivity inmprovements, opportunities exist for encouraging the development of more advanced analytical techniques and tools for product designers, to better link product performance to process capabilities. Even more importantly, however,

we suffer from a lack of computer interface standards among production equipment suppliers. Too much specialized translation software is required for interconnection, reducing information processing effectiveness and adding to engineering cost. Industry must increase its attention and efforts devoted to standards activities, such as the Semiconductor Equipment Communications Standard, to rectify this situation.

Finally, I firmly believe the U. S. market should remain open and our free enterprise system preserved. U. S. industry has higher labor costs than most of its competitors in other countries, and that is not likely to change, but we have the technology to help offset these labor costs. Unfortunately, the application of this technology often comes in the form of capital facilities and increased R&D; and the U. S. also has among the highest costs of capital and engineering in the world. The federal government can help best in this area through incentives such as making the R&D tax credit permanent (as proposed, for example, in H.R. 1957), and by ensuring that such incentives are applicable to the important aspects of the manufacturing process and introduction of technology into manufacturing. As Erich Bloch, Director of the National Science Foundation stated recently, "we need to establish a sense of national priority in manufacturing".

MANUFACTURING PRODUCTIVITY REALIZATION MODEL



*Emphasis: Customer Expectations, Simplicity/TQC, with JIT, In-Lining, Flexibility Concepts.

**Linkages with Product CAD, Distribution, Financial etc., Information Systems

ATTACHMENT A

50

LAURENCE CURT SEIFERT

Mr. Seifert is AT&T's Vice President, Engineering, Manufacturing and Production Planning. His office is located at One Oak Way, Berkeley Heights, New Jersey.

Mr. Seifert assumed his current assignment on May 1, 1987. His previous position was Vice President of Manufacturing Research and Development at AT&T's Engineering Research Center in Princeton, New Jersey. Prior to that, Mr. Seifert was Director of Engineering at the company's Oklahoma City Works, where he completed a modernization and automation program for the facility, which manufactures AT&T's digital switching systems and computers. He was also Director of Engineering at AT&T's Transmission Equipment manufacturing works in North Andover, Massachusetts.

Mr. Seifert began his AT&T career in 1957 at Western Electric's Kearny Works in Kearny, New Jersey. He has also held various engineering, manufacturing, and installation positions at Western Elelctric's Corporate Engineering Division in New York City, the Company's Regional Center in Sunnyvale, California. Mr. Seifert's career also included a tour with AT&T Headquarters Marketing in New Jersey.

Mr. Seifert was born in Jersey City, New Jersey and holds a Bachelor of Science degree in Electrical Engineering from the New Jersey Institute of Technology.

Mr. Seifert is a member of the Editorial Board of the AT&T Technical Journal; he serves on the College and University Relations Executive Policy Board and the Education Committee of the AT&T Foundation. He is also a member of the Research and Development Council of New Jersey and the Industrial Research Institute.

Mr. MacKay. Thank you. All right. This is an indication of our thesis that if we ask people to really summarize and zero in, we can get the issue on the table very quickly and in an interesting fashion and allow maximum time for dialog.

Let me set the rules basically. I will recognize members in the order that they came in. That will be Mr. Brown, Mr. McMillen if he comes back, Mr. Henry, Mrs. Morella, Mr. Packard and then myself. Mr. Alan Magazine who is the president of the council on competitiveness and one of the members of our advisory committee has the privilege of interrupting whenever he can get the Chairman's attention.

All right. Let's start with Mr. Brown.

Mr. Brown. Of course, the thing that we focus on here, I guess, first is understanding the problem and all of you gentlemen I believe have made a very large contribution to that and then secondly we have to ask what can we do about it. I note that both Dr. Branscomb and Mr. Sumney have made some specific suggestions, Dr. Branscomb focusing on some transformation within the Department of Commerce and presumably a lot would be focused around the agencies in there like the National Bureau of Standards and some of the other agencies.

Mr. Sumney has endorsed this idea of a national advisory committee on semiconductors and SEMATECH. There is nothing incompatible with these suggestions that each of you have made. They could both be incorporated in a program which presumably would assist us in re-establishing our competitiveness, am I right?

Dr. Branscomb. I don't think that they are necessarily incompatible. I think there is a policy issue that this task force, which takes a longer range view, might want to think about: What is the appropriate agency to take responsibility for the federal participation and resources for SEMATECH, if indeed it is concluded that SEMATECH is the right thing to do?

The money is in the Department of Defense in the way we have the budget structured today and the general political acceptability of a significant Federal participation in a technology activity aimed at commercialization is probably greater for defense participation.

But I personally question whether the arguments that were used by the DSB report for a compelling defense role are entirely persuasive. I suspect that an agency that was seriously in touch with commercial industry and understood its problems and needs might in the longer range do a better job of being the sponsor of SEMATECH. However, I think that the Congress and the Executive are going to have to face up to SEMATECH on a time scale much shorter than the one implied by my suggestion that we need a Commerce Department that takes more technological responsibility.

Mr. Sumney. I agree that there is no fundamental inconsistency between the suggestion that he had and the two that I offered.

I agree that the time frame is very critical to the success of SEMATECH and that the Department of Defense, having completed its Defense Science Board Task Force Study in recommending a very similar approach, sort of closely aligns for an immediate methodology for pursuing SEMATECH through the DOD and in the short term, that may be the best thing to do for SEMATECH

while in the longer term, we may want to look at a different approach.

Mr. BROWN. We are all aware of the fact that there is much activity going on in both the Defense Department and in certain other departments than Commerce which vitally relate to this problem of competitiveness. The national labs, for example, are in both the Defense Department and the Department of Energy and possibly some other departments.

We have valuable contributions that can be expected from various sources but if we are going to provide leadership for a program focused on U.S. civilian economic competitiveness, we have to provide for a structure that gives that leadership.

I don't think we want to give it to the Department of Defense and I don't think we want to give it to the Department of Energy. I think the Department of Commerce is a logical locus, institutional locus, for that.

Now the problem will continue as it does for all complex programs of how do you bring about a proper integration. In a bureaucratic structure, that is extremely difficult and in over 20 years here, I have never found a legislative solution to providing a fully integrated multi-department program that makes it work effectively. Sometimes it happens by accident, but it is unusual. But that would be a first step, to have a structure which provided leadership and placed the responsibility for coordination in some particular locality.

I am very much interested in the suggestion for a national advisory committee on semiconductors and I was hoping to give serious thought in this session of Congress to passing legislation to do that, although it is likely to have to be included in a somewhat broader package of legislation like Senator Hollings has over in the Senate in which we possibly could cooperate with him and include something of this sort in legislation that we could get cross-agreement on.

I have no further questions.

Mr. MACKAY. All right. Mr. Henry.

Mr. HENRY. Thank you, Mr. Chairman. I very much appreciate the reminder, I believe, that Professor Nelson gave us that is very important, that we have some sense of subject specificness or industry specificness in designing technology policy lest we do what politicians often find ourselves doing, we are all for justice and the question is, what do you mean and then you get on and you have to be germane and relative to different ways in which it applies in different settings.

I am kind of intrigued with the whole model, for example, of USDA which was brought to mind and wondering whether and my chief concern of my region, of course, are automated manufacturing technologies, of the possibility of something dramatic which would probably have been equally dramatic back in the 1930's when the Ag Extension offices were established.

In taking that as a model and getting some national extension service as it were and really model the way USDA's extension services are, decentralized right out there in each of the states with each state having a center and field offices with a specific mission focus of applied manufacturing technologies.

My understanding and I would just like to pursue this a little bit more, I have some of this in my district going on very rapidly and one gentleman and firm which I will not name specifically although it has received some national recognition, my understanding of the vision of this is that you will get to a point of such automation in the manufacturing process that the labor cost differentials that we have will be offset by the transportation cost differentials of overseas countries.

Thus, the distance between manufacturing and marketing costs, ultimate marketing costs, diminishes to the point of regaining competitiveness. Is that do you think fair? Are we really that far? The fellow I am talking about, for example, turns on his factory and watches it and goes back and he tells me that the only thing that the Japanese are doing in the state-of-the-art, what is it, metal stamping but it is completely automated, he pushes in the change of product and out it comes is that the Japanese run them at night with no one there.

Mr. SEIFERT. We have experienced the same thing. It is possible that the manufacturing labor in many assembly operations is far less than the transportation costs. However, you need to understand that these countries are bringing up their white collar labor to our level and their engineers and scientists also are far less expensive than ours and there is a lot of engineering effort that goes into those kinds of factories.

So it is not just the traditional labor, but it has been the new labor, the engineering and scientific labor and that can go offshore as well if we are not careful and that is why we need to maintain our leadership in those fields.

Dr. BRANSCOMB. May I make a comment? When I was at IBM we made a study for a particular product to try to address this question. That is, we assumed that a Japanese company was using the same technology that we were using.

They were making a product in Japan, we were making it in the U.S. and we compared the cost of U.S.-built products shipped to Japan with the cost of Japanese products shipped to the U.S. Under those circumstances, with all of the duties, freight and other direct and indirect costs, costs of capital and labor, it turned out that indeed using the right technology, the Japanese product landed in the U.S. at the same cost base as the U.S. manufactured product.

In other words, there was about a 15-percent difference in import and shipping costs which was compensated for by a 15-percent Japanese manufacturing cost advantage. But if one focuses just on those kinds of comparisons, you lose sight of the power of really good technology and engineering to make factors not of five percent, but of 20 and 30 and 40 percent difference.

To me, the key issue in this whole downstream engineering discussion is not the amount of labor required to assemble and test the products in the factory. That can be reduced to low levels in

most mechanical assembly situations, to the point where having a factory with no light switches is irrelevant. A few people in there doesn't add anything to the cost.

The real issue is all of those engineers and indirect personnel that people don't show you when they take you on a walk through their automated factories. They are in another building somewhere, but they are responsible for keeping all the systems running and they are expensive.

But their effectiveness in turn really depends on the people who design the product. The IBM Pro Printer is a very inexpensive, almost consumer product, of a type that everybody thought would always be sourced offshore. That product is not only quality competitive, but cost competitive built in the United States.

The reason is not the automation in the factory, which is probably too well automated, it is because a very small number of engineers did an incredibly good job of designing the product to be manufactured. As a result it had at the time it was built about a third as many parts as comparable offshore designs. That is what made the Pro Printer competitive. I agree thoroughly with Professor Nelson's observation that if you are looking at remedies for the ills of major industrial sectors, you had better be very specific to all of the factors that determine success and failure in those sectors.

But if you are looking at generic investments to try to upgrade manufacturing industry in general, there is a great deal that can be done with education and with research that is quite generic restricted only to the domain of the manufacturing industry.

Mr. HENRY. May I ask one more question?

Mr. MACKAY. Certainly.

Mr. HENRY. We were discussing what promotes technological science and its transfer and exploitation and we had some suggestions and constantly we hear the whole issue of R&D credits, ITC credits, factory renovation credits.

I guess I would like to approach the question a little differently too in terms of what hinders and erodes and stands in the way of technological science application and exploitation and other than simply saying that we don't have R&D credits, rather than just dealing with the flips of those, what are the key roadblocks right now other than the tax credits?

I guess I am asking, are intellectual property right violations really a substantial problem? Is the Japanese trade issue, well, obviously it were in the semiconductors, but how do you crack that without doing the same which none of you seem to be saying is a good policy? Are the liability issues very real in this emerging technology or are they not so real in this technology and they, in fact, are the liability problems in traditional manufacturing, perhaps a hidden incentive to get away into new forms of manufacturing, what are the hindrances right now that are there?

Dr. BRANSCOMB. I believe, first of all, the principal impediments to U.S. competitiveness can be found here in the United States. You don't have to go abroad to find them although if you go abroad, you will see some things that will tell you where to look.

I believe they are (1) lack of focus on the technological possibilities and strategies to fulfill them by senior industrial management, (2) the failure of this country to accord importance and prestige to

the manufacturing function, which has many indirect consequences both in the firm and in education, (3) the failure to capitalize our workers with modern tools, which gets back to the savings rates and the macroeconomic problems, and (4) the improving but as yet, I think, unsatisfactory level of information diffusion between the knowledge generating sector in our society and a very large group of those who most need it; namely, the firms that are smaller than a billion dollars a year in gross sales which is roughly the level at which you do or don't have a corporate research laboratory.

Mr. HENRY. It is intriguing then that they may and I am not suggesting you are putting them in order but two we have really focused quite a bit on in our discussions was constant debate on the lack of modern tools and the tax credits or whatever it may be to get the incentives to rebuild the factory.

A lot of talk in our committee over the last couple of years and elsewhere has been in technological transfer and diffusion, but I don't know how in the world you legislate technological imagination of senior management and I don't know how we deal with the whole problem of the perceived image of manufacturing not only in the business community and in the business schools but in the public. We still think of the Life of Riley fellow with the lunch pail, I guess.

Dr. BRANSCOMB. If you will excuse me for usurping this platform.

Mr. MACKAY. Usurp away.

Dr. BRANSCOMB. Just one bit more. I don't believe there is any way that Congress either can or should attempt to legislate the attitudes of Americans. What the Congress can do is in certain circumstances to alter the environment within which Americans make decisions.

I think corporate managements are pretty responsive to the environments within which they work and with the danger of a physicist starting to invent economics and I will quickly defer to Professor Nelson, I will give you one example of how I could conceive of persuading corporate management to take technology strategies more seriously.

Why don't we tax capital gains at normal income rates for all capital gains made over a period of less than six months and why don't we not tax capital gains at all for capital that is held five years with a sliding scale in between.

I don't know whether that is financially possible but I predict that it would have an immediate effect on the financial analysts of Wall Street when they look at strategies of companies whose stock they are evaluating.

Mr. MACKAY. Could I usurp your usurpation long enough to say what if you worked upstream from that and said capital gains in effect, the part of the capital gain that is the churning of the market would be subjected to a surtax? Churning is the word. In other words, why don't we have a surtax on the quick in and out and then a normal tax at the six month level and then tapered down to nothing?

Dr. BRANSCOMB. As I have said, I have already gotten beyond my limits of competence. [Laughter.]

Mr. MACKAY. Excuse me for interrupting.

Mr. HENRY. Thank you, Mr. Chairman.

Mr. MacKay. Mr. Packard.

Mr. Packard. Thank you, Mr. Chairman. I apologize for being a little late this morning. I had a conflicting speech to a group of high school students and I had such a stunning opening statement that to pass that up was a big sacrifice, Mr. Chairman. [Laughter.]

So I would like to ask unanimous consent to submit it for the record if I may, please.

I did arrive in time to hear most of your comments, Dr. Nelson, and all of the rest and I appreciate your being here and your statements and your expertise.

In the U.S., we often leave manufacturing and marketing to the reseacher, to the developer, to the discoverer of technology that leads to products rather than having a built-in marketing system and manufacturing system that will pick up new ideas and run with it.

Often the researcher is not qualified or is certainly one of the less qualified to get into the actual production and marketing. In our institutions, in our universities, do we have courses in our curriculums specifically designed to instruct people or students in manufacturing, in product development. I know we do in marketing, but do we in product development? I will ask the two professors.

Dr. Nelson. My understanding of that is that there is a lot of variation across schools. My understanding is that for a long time at the Sloan School at M.I.T., for example, there has been a collection of courses that have been concerned with the process of manufacturing and the management of manufacturing, some of these really being pretty close nuts and bolts to technology and some of them being much more oriented toward manufacturing techniques.

I understand that there are a different but in spirit similar set of courses at the Harvard Business School. I think in contrast of the University where I had been for many years until this last one, the School of Organization and Management at Yale has virtually nothing on any of these topics.

Mr. Packard. So what we do have is relatively small and rather isolated into specific schools and not a general curriculum?

Dr. Nelson. That is my suspicion. It is also my belief that the kinds of discussions that you are having here and we are having together are now going on both in engineering schools and in the business school community and there is a lot of ferment to put in place more courses concerned with manufacturing and the relationship between manufacturing technology.

Mr. Packard. What role should the universities take in this whole competitive issue which is of vital importance to the United States? What would be an appropriate role or a role which we now do not take in our university systems in the competitive issue?

Dr. Nelson. There are two different kinds of roles that currently are becoming more prominent. One of these is concerned exactly with some of the questions I think we are going to get to later on this morning and that is the appropriate roles of universities as loci of research in interacting with companies in cooperative and joint ventures.

Where does the university line and research end and where does the company line end and begin and what is the appropriate mode

of interactions between the two, the engineering research centers being one experimental probe at some new institutions there?

The other aspect of the matter that you are questioning about relates it seems to me to the kind of research and teaching that goes on at universities that are concerned with the nature of U.S. competitive problems and sort of analyzing the problem as contrasted with participating with industry in forging a solution.

I see in many places the development of many more courses concerned with trying to comprehend the matter, an increase in research and writing in a number of fields concerned with this.

Mr. PACKARD. Mr. Seifert, you spoke to that issue a little bit. Do you think this process of more cooperative efforts between government and industry will come about naturally or do you believe there should be some government role to encourage it or do you think that industry needs to do more? How do you see this coming about?

Mr. SEIFERT. Let me, if I may first comment, we counted 30 major initiatives in universities on manufacturing somehow associated with universities either through separate corporations or actually within a university. In most of those initiatives, the industry has been contacted for support and is supporting.

Those initiatives are focused on the technical side, on the research or the applied engineering. There were very few initiatives which link up what you call the marketing side. There have been some traditional schools, like the Sloan School, that do a very good job of that. I think that is the situation.

I think it has to be a joint industrial, academic and government supported program. It is not just the funding but the expertise. The universities sorely need experienced people from industry. We are moving a lot of people on part time, not only teaching courses but into these programs. We have the usual problems of competing for salaries because industry pays a little better but I think it has to be a three-way street.

I think the government needs to stimulate this and someone mentioned create the environment whereby this is an important national initiative. One of the ways we do it is by funding the research that tells these schools that it is important that they work on this. Again, most of that has been aimed at the technical side.

Dr. NELSON. If I may pick up on Mr. Seifert's remarks and come back to your question, it is my belief that there is much less interaction and joint work and joint training between American engineering schools and American business schools than there ought to be.

In most campuses that I know about, these are two shops on their own bottom and there is not much in the way of training of young engineers to become managers. Many of them, the best of them, soon will become and on the other hand, the business school training often and in most cases does not dip into giving those students an appreciation of technology or technical change or the management of the research function or the interaction between research and manufacturing that it ought to. I think this is unfortunate.

Mr. PACKARD. One of the successes in Japan and other foreign competitive nations, France, Germany and there are others, is that

they have developed and certainly exploited the integrated infrastructure process.

We are developing in some isolated circumstances here in this country consortium of industries in an effort to perhaps duplicate in the private sector some of the same things. Do you see that becoming more and more of a need, more and more of a trend and, if so, how will that affect small business competitors with these large consortium of businesses? Yes, please, Dr. Branscomb.

Dr. BRANSCOMB. The question of what advantages the Japanese have gotten from collaborative research across company boundaries and between the government and the private sector is a very high priority area of science policy research right now.

One of those who studied it is Dr. George Heaton from M.I.T. He has just returned from a year in Japan studying that subject and I believe I am not misquoting him by saying that the advertisements exceed the reality, that in fact, from a technology output point of view those collaborative research programs haven't had as much leverage as one might have thought.

However, I believe that those consortia are very important and that they might be even more important here than in Japan. This country needs a way to find a legally permitted method for the self-selected voluntary participants in an industry to say that we have a common set of technical problems, we have an instrumentality to discuss them in enough technical depth to get below the superficial level of advocating tax credits or whatever is easy for everybody to do without study. Out of that might come the consensus we are all waiting for in which the private sector comes to the government and says, "Here is the kind of help we think is appropriate."

I would go back to the moral that I think Professor Nelson taught us in his reference to agriculture. He made a very important statement. He said, "The farmers asked for it" and the farmers said what they needed. We don't have that on the industrial side.

I think back on some of the civilian industrial technology programs when Herb Hollomon was assistant secretary of Commerce. We sent Ph.D. engineers down to trade associations of fabric manufacturers and we lectured them on how they should be doing their technology, and they didn't take it too well.

So I really do believe that we need an industry consensus mechanism and it has to be sectorally specific.

Mr. PACKARD. Why has the microchip, the microelectronic industry in the United States fallen on such hard times and has that process paralleled the difficulty that we have seen in the past on the automobile industry, the steel industry, and the textile industry and other industries where we have been beaten by foreign competition?

Are there characteristically similar patterns in the troubles of the microchip industry and these other industries and what does that say in terms of the free enterprise system versus the government sponsored and government subsidized systems in some of our competing nations?

Mr. SUMNEY. There are a number, I think, of contributing factors. One of the things that the microchip industry has maintained in the United States has been a preeminent design capability and

to do that, they have had to devote a significant portion of their sales revenues to R&D. This industry averaged last year ten percent of sales on R&D which is higher than any other industrial sector.

Because of things outside of their control such as the dumping problem, they have fallen behind in the ability to competitively manufacture technology drivers, very high volume products, and recognizing that, they feel and I think rightfully so that perhaps the only way that they can recover in time the ability to manufacture competitively is through a consortium.

This is an industry that is still moving very rapidly from the standpoint of technology. It is becoming more and more capital intensive and it seems to make tremendous sense to try to do as much generically as you can do rather than having to address it all separately and independently with the inefficiencies that are associated with that.

Mr. PACKARD. In that area apparently then you are saying that there are some dissimilarities between that and say the automobile or steel industry where they did not put a great deal into R&D or upgrading their equipment.

Mr. SUMNEY. Absolutely.

Mr. PACKARD. They simply were relying on old technology and old systems.

Mr. SUMNEY. They have made a conscious decision over the years as to where they wanted to put their R&D investment which has been consistently larger than any other industry and the decision that they have made all along and I think it has been the right decision has been to maintain strength in design and they have done that. They are still very innovative in that area.

Mr. PACKARD. Very good. Dr. Branscomb.

Dr. BRANSCOMB. First, I would like to agree with Mr. Sumney's statement that the merchant semiconductor industry has maintained its strength in the application marketplace. That is the place that has the biggest leverage for the economy and it has maintained U.S. primacy in specialized design of microprocessors and products made out of them.

If you had to choose between giving up the logic and end product industry versus the commodity dynamic-memory chip, you would be happy to give up the dynamic memory chip if you had to make that choice. It is not a choice we wish we had to make.

The industry's strategy aimed at end products, was in part responsible for the manner in which the independent semiconductor industry evolved; that is, very bright innovative entrepreneurial technical people left the larger semiconductor manufacturing firms and started up firms of their own aimed at a niche market.

They did indeed put a lot of money in R&D. It was R&D as he points out, in design and application primarily. The fragmentation of this merchant industry made it difficult for them to put as much money proportionately into process R&D for the new processes to make new kinds of devices of smaller scale as was the case either with IBM Corporation or AT&T or the major Japanese companies.

So to some extent, the problem our industry faces in my personal opinion is the need for some industrial aggregation or sharing or

partnership, some mechanism to pool the process technology interests of these large numbers of firms.

Within the IBM Corporation, which you must know is the largest semiconductor manufacturer in the world and spends more on semiconductor R&D than any other single enterprise in the world, process technology is very healthy. But IBM shares many of Mr. Sumney's concerns, at least I understand they do, based on the fact that IBM alone can't sustain all of the small innovative tool and process companies that the whole industry shares and needs. For that reason, IBM has been participating in the SEMATECH discussion.

Mr. PACKARD. Mr. Chairman, would you permit me one additional question.

Mr. MACKAY. Absolutely, but wait, Dr. Nelson wanted to comment on that if you could wait and let's get a full panel comment before we go to the next question.

Dr. NELSON. Yes. Most of my observations have already been made by my colleagues up here. Your question was concerned with what is similar and what is different about semiconductors as contrasted with automobiles and steel. I would like to observe a little bit on that again to support my earlier observation that you want to pay careful attention to the details of the industry with which you are concerned.

I think there are several factors that have cut across the board. One of them is that in all of these industries the fact that during the 1960's and 1970's the world increasingly became one market, was extremely important in all of these industries.

Prior to the 1960's, the American companies had the advantage of selling to the largest common market in the world and industry abroad was handicapped relative to U.S. industries because they sold on a much smaller market and as the world became one market, that particular advantage which American industry had been blessed by since the last part of the 19th century became less and less important in strength.

The other thing that happened which I think was very important, I think my colleagues here would agree, was that throughout the 1960's and 1970's, other countries in the world built up their own scientific and technical and educational infrastructure so that this enormous advantage the United States had during the 1950's and early 1960's relative to everybody else dissolved and that is common in one world technologically.

But then the differences start coming in and they are highly relevant. Most of the issues that Larry Sumney has been talking about in the proposals that he has mentioned are associated with the fact that while there are some giants in the industry like IBM and AT&T, this is a quite fragmented industry and there is not much in the way of upstream/downstream integration.

Indeed, I take it that SEMATECH is concerned very much just with that fact. On the other hand, if you think about the automobile industry in the United States, this has been an industry of three giants. It is not a fragmented industry at all and there has been a considerable amount of upstream/downstream integration.

General Motors in the post War period developed a policy of reaching quite far upstream to control its own supply and its own

components and much of the discussion regarding what has gone wrong with respect to the American automobile industry has related to giantism, complacency associated with giantism and probably too much in the way of attempting to integrate upstream.

So again, the structures are different and therefore, the kinds of policies that Congress will be entertaining and hearing proposed are going to be different. You are not going to hear SEMATECH from the automobile industry. You may hear something else but not that.

Mr. PACKARD. Very interesting. So we can profit from the experiences of these other industries but we cannot rely on their experience in looking for solutions to our technical industries.

Dr. NELSON. Yes.

Mr. PACKARD. The last question, American industry tends to depend on a very easy marketplace, namely, the Defense oriented or related marketplace in this country. It is such a predominant marketplace and contractual arrangements often is the easier way for them to market their product and in doing so I seem to feel that they may have shied away or in some cases almost abandoned the non-Defense related marketplace to our foreign competitors.

Is that so and if so, what should be done to change that because we still find in this country a strong Defense oriented marketplace?

Mr. SUMNEY. I have a comment on that. The status of the semiconductor industry in the United States has changed drastically over the last five to ten years. When I started the VHSIC program in the late 1970's, the goal of the program at that time was to structure a program where DOD could address its integrated circuit needs based on the strength and the leadership of the commercial sector.

In order to do that, we structured a program that would foster the teaming between commercial companies and aerospace companies. An example at the time was Motorola teaming with TRW and in the time since, that has been broadened to include Honeywell as well.

What we saw as the program progressed is that the teaming arrangements that were established did indeed work but because of things that we have already mentioned here today such as dumping, the commercial sector started to lose some of its strength.

What we see now is that if the investment that this country has put into the VHSIC program which is nearly a billion dollars in R&D is to receive maximum utilization, the commercial sector is going to have to regain its strength in manufacturability for a number of reasons, one of which is to support the infrastructure which the aerospace companies depend upon just as the commercial companies do for equipment to manufacture their product.

So we see a shift that has occurred and I think the government has to recognize that shift and why it happened and now the policies have to be different than they were as recently as 1978 and 1979. It is a very dynamic situation.

Mr. MACKAY. Dr. Branscomb.

Dr. BRANSCOMB. But over a perspective of more like 20 years, I think, the predominant trend has been opposite to the one that you suggest, Mr. Packard, in the following sense. First of all, when I was director of the Bureau of Standards, the government was

buying about 14 percent of the general purpose computers made in this country and it is now down to somewhere in the eight percent range, I think, something like that.

In any case, both in purchases of electronics and of computers, the government has been a small and declining segment of the U.S. commercial market. In fact, that has led to the fact that a fair number of commercial companies are not interested in taking bids for product, from the Defense Department a variety of reasons. One reason is because there are specialized requirements, such as hardening against radiation and the like, which would require the diversion of technical talent to solve which adds nothing to their commercial competitiveness. Secondly, the development times and deployment times for Defense systems are so long, often ten or 12 years, that if you make a major commercial commitment to a Defense system, you are committing yourself to that technology for ten or 12 years in the future and maybe longer when, in fact, the technology is probably obsolete in three.

So I think one of the important areas of policy work that needs study is the question of to what extent might the Defense Department itself achieve its own mission more cheaply and more quickly and with better technology modernization if it found a way to work with the commercial industry more directly rather than the current pattern of working with companies that are specifically set up to do business with the Defense Department.

It is an area of research that my colleagues and I are getting into but I would just close with one other observation. There are a number of predominately commercial companies of which I would name IBM and GE as two examples which also have very large Defense contracting businesses.

It is interesting that those companies segregate their Defense contracting business into a business unit that has very large barriers between that unit and the commercial sector.

The reasons for those barriers have a lot to do with accounting and keeping the government auditors out of the commercial books and one thing and another, but some of it has to do with the fact that these companies very often feel that their commercial technology is moving faster and is more precious to them than that which if they were to make it available to defense, they would have to share with the second source participants in the project.

We all understand why the Defense Department wants more than one source for its technology. I believe we can also understand why a highly competitive company is unwilling to give up whatever competitive edge it thinks it has in order to satisfy that defense requirement.

Mr. PACKARD. Thank you very, very much. Thank you, Mr. Chairman.

Mr. MACKAY. We are about to re-experience what we experienced at the last hearing. We finally get the problem kind of laid out and then everybody starts thinking about more basic level questions. We have touched all around this. I want to go back to it.

The U.S., for reasons that are historic, possibly seems to have an infrastructure that is based on the idea of a number of islands. We have universities doing their thing. We have federal labs that are in all kinds of illogical places. It has taken me now three years to

try to figure out why we have all these labs in the Department of Energy and the answer is that that is how it happened. The answer is historically that it happened that way.

We have a Department of Commerce which it would seem to me, if we really thought economic competitiveness in the next century or the next two decades was going to be what military competitiveness has been, then we would be beefing up a Department of Commerce the way we had the Department of Defense. We now have a Department of Defense which it seems to me suddenly realizes maybe in order for us to stay alive, we have to start getting into what the Department of Commerce ought to be doing.

Now I want to just ask the question. Here we have a spectrum of people from the all together academic to all together practical. Mr. Seifert, you are overhauling the wreckage of the past and trying to make it work. You are trying to figure out whether what we are doing, Dr. Nelson, makes sense. And you, Dr. Branscomb, have been on both sides of this and Mr. Sumney, you, it seems to me, are a person who is saying, "Damn the theory, I am dealing with practicalities."

I want to ask: why would it not make more sense for us to organize the federal government as if being organized rationally would help with the problem. I would like to just start on my left, with Dr. Nelson, and move to the right.

Wouldn't it make more sense for us to do like the Japanese and the French and the Germans and organize our infrastructure so we could deal harmoniously with this, instead of starting with a consortia, which is the right way to do it, user oriented and then work back in a way so we finesse this question of industrial policy? Industrial policy is all right if it is in the Department of Defense but otherwise, it offends the idea of government usurping the private sector initiatives. In other words, government can usurp but only if you all ask for it. Have I asked that question in enough different ways? Dr. Nelson.

Dr. NELSON. You have asked many different questions in many different ways and let me offer a couple of observations rather than trying to give a complete response to even one fascinating part of it.

One observation is that while you mentioned Japan, the Federal Republic, France, Britain, whatever in one breath, the structures possessed by these different countries are enormously dissimilar and to my knowledge, none of the others has anything like a MITI structure.

By the way, my understanding of the effectiveness of the MITI structure is not incompatible with the observation that Lew Branscomb made some time earlier. While that structure certainly played a very important role during a certain period of time in Japanese post World War II development, there is an awful lot of mythology that has been built up ascribing to MITI credit for a whole bunch of other things, for many things that might be better described as other factors in Japan like the enormously high investment rate, like the tremendous investments in education that the Japanese have engaged in and so on.

To return to your question about organization of infrastructure and organization of policy bearing on industry, if I may use that

term which is as yet uncontaminated, whereas industrial policy seems to have all kinds of other connotations. It seems to me that if you look over the last 20 or 25 years in policy deliberations in the United States, from the time that Lew Branscomb was at the National Bureau of Standards and I was with the Council of Economic Advisors, there has been an attempt to somehow locate or coordinate these kinds of policies somewhere and the idea that Commerce should do it has come and then it has faded away and then it has come back in again.

Then the issue is always, if not Commerce, where? Well, from time to time we have tried to put the technology oriented part of the policy into the National Science Foundation and I guess with Erich Bloch's presence as director there, that is a congenial home for some of it now. But again, it isn't quite right and it is very difficult to link up things sponsored through the National Science Foundation to issues of management and competitiveness. Since it is a science and technology house that can become more applied, we have been able to do that with it, but it is very difficult to sort of link that into a structure which feeds into business and management.

There have been notions about doing things in an office somewhere in the Executive Office. That really hasn't worked either. So often we will do things by default out of the Department of Defense.

I don't know the answer to your question but I think it is an awfully good question. But history over the last 20 years or so suggests that it is a very difficult question to wrestle with. That is not an argument for not continuing to wrestle with it and doing better on it.

Dr. BRANSCOMB. The old adage that you can lead a horse to water but you cannot make it drink seems to me applies here. The Department of Commerce as currently constituted and as constituted in most of its history has no particular stomach for a more active role of this kind, notwithstanding the large number of scientific and technical agencies in the Department. Their missions are very neatly circumscribed and don't constitute in any sense an open-ended obligation to try to negotiate a partnership with the private sector that comes to grips with these technology issues.

Second, I am reminded when Larry mentions a National Advisory Committee on Semiconductors analogous to NACA, it is kind of interesting to think back on the history of the NACA. It did start out in early World War II as an advisory committee in the Defense Department. It was an agency that funded research.

But as it demonstrated its value and it demonstrated some important areas of activity and people got confidence in it, then they said, "Let's give this body the capability to actually do something about its advice". Hugh Dryden was the deputy director of the Bureau of Standards and a fine R&D manager. He came in and built the technical competence that even today we see producing fan jet engines and wonderful things.

Then NACA became NASA. So from little seeds, great trees do occasionally grow. Therefore, in many respects it is probably better to proceed down that pragmatic path of inventing the thing you

have to have to do the job at hand and letting the future take care of itself.

What is missing in that strategy is what Dick Nelson has just been speaking to which I think is the most important thing to happen, that is for the Executive Office of the President to take seriously their management responsibilities for R&D.

Here we have a government which is spending some $67 billion dollars a year in R&D and is leveraging the other $70 billion of private R&D through the government's regulatory actions and behavior in the marketplace. Yet for the last two administrations, both of the last two Presidents, that is, Mr. Reagan and Mr. Carter, didn't get around to appointing a science advisor and director of OSTP until the middle of the spring. This was after every other senior job had been picked, after the White House staff was completely locked up. Hence there was no bargaining power available for the candidate to negotiate with the chief of staff or with the President about what his relationships might be with White House offices, with OMB and with the cabinet offices.

The assistant secretaries for R&D were chosen before the Science Advisor could have a possible voice in their selection. Had he had a voice in their selection, he might have had more responsive behavior on their part.

So if I could change one thing, it would be to persuade every political candidate of both parties to pledge that they will have a designee for the science and technology Special Assistant to the Ppresident before the first of January or at least before the 21st of January, when they take office.

Second, I do think some structural attention to OSTP is needed and again I don't know that you can force that on a President. Even though it is a legislated body, a creature of the Congress, indeed of this committee. Yet it seems to me that OSTP must be given some direct capability and responsibility for extending their scope into the economic dimensions of science and technology policy.

Other people writing on this subject have from time to time made many suggestions. Pat Hagerty suggested a kind of joint OSTP and Council of Economic Advisors operation. Ed David has suggested a few years ago in print that the Science Advisor should be given some formal assigned responsibilities with respect to the program evaluation function at OMB.

I think there are a variety of things of that kind worthy of exploration. If we had a strong OSTP (and I believe today it is weaker than it has been for a long time) then we at least would have an instrumentality capable of focusing the debate on the defense/civil trade offs and on trying to find organizational options that fit the personalities and the current political situation and the art of the possible.

Mr. MacKay. Thank you.

Mr. Sumney. I agree with almost everything that has been said previously. I would like to just offer a few comments. First of all, our infrastructure is much different than other countries have. One of the key things that we have that I think we need to make great use of is the strength of the research capability in our univer-

sities and the overall strength of the university system in the United States.

All things considered, I think that the concept of the National Advisory Committee is perhaps the best approach. I think its authority should be derived from the prestige of the people that are appointed to it.

I think that those people need to reflect the cross-sections of the components in our infrastructure and over time. If it is successful, perhaps authority can evolve into other areas but I do not think that it needs to have financial control at the beginning, that it would be an advice/guidance coordination function.

But I think it would greatly serve to make things more efficient and operate more smoothly.

Mr. MacKay. Mr. Seifert.

Mr. Seifert. Well, I am neither an economist nor an expert on government.

Mr. MacKay. That is probably the reason that you should have more credibility.

Mr. Seifert. And I am last. Let me say that like the farmers, I think we have come to the government, saying that we do have a problem and it is in semiconductors. That is the place to start. There is one agency that stood up and said, "My God, they are right" and that is the Defense Department.

They have one aspect of their work. They give us an application to try to bring our technology to commercial use or to application, anyway, which is nice. I would hope that if others listen, we don't take that down before we do something else, because we do need help.

Mr. MacKay. Now your answers made me realize I asked the wrong question and if the committee will indulge me and you will, let me try one more time to frame what I was asking. Instead of 15 questions, let me try to frame one.

Here is my thesis. We are about to get into a situation where the amount of money available for science and technology and basic research and development in government is going to be very, very limited. We are not going to have the luxury of deciding we want to do a super collider without figuring out where the money is coming from.

It is going to get to be zero sum. We are going to have to, in order to do something else, cut out something. Can we afford to continue the luxury of national labs scattered all over everywhere without an oversight mechanism in the government, without a coordination or peer review, some of whom seem to have outgrown their existing or original mandate, some of whom are engaged in fine public sector entrepreneurial activity of getting out and looking for something to do that has money attached to it?

Can we afford that and if we can't, how do they fit into this idea of a decentralized decision making process but still give us a chance to get the most bang for our buck? How do you kill off something? You took NACA and brought it through to NASA. Now let me take a lab that was designed to do something, the need for which has disappeared and which is still showing up in a line item every year and which has hundreds of top quality scientists doing something.

So I am saying, if we don't have an industrial policy, how do we address the question of at least making sure everybody is doing something we need done? Yes, Dr. Branscomb.

Dr. BRANSCOMB. I think the answer to your question is no.

Mr. MACKAY. That serves me right.

Dr. BRANSCOMB. In other words, the current situation is in my opinion undesirable because it is not the result of thoughtful government-wide trade-offs pursuant to a technology policy as distinct from an industrial one. It ought to be.

The OMB does their special analysis of the budget to look at the R&D content after the budget is all finished. They don't know what it is until it is finished. Nobody looks across the President's budget in any serious detail at the R&D trade-offs until after the budget is put to bed.

So there is not the locus of responsibility within the Executive Branch to do that.

Secondly, I think in our thinking about R&D and other activities we have what some have called an "edifice complex." It is interesting. The people are what is important in those laboratories. It is not the building. I once years ago observed that my tiny astrophysics laboratory at the University of Colorado cost two million dollars a year to operate and it was in a two million dollar building.

I then looked at the NASA budget and discovered that the NASA budget was $6.5 billion and they had $6.5 billion worth of facilities. Roughly speaking, that is not a bad rule of thumb: The physical facility is about one year's operating cost in most research operations. If that is the case, we ought not worry so much about cost of buildings. We ought to build new buildings when we need them and we ought to throw them away when they are no good. We ought to focus on the people.

I believe modern R&D management in industry knows how with compassion, with sensitivity to people and to the value of the continuity of work to manage down organizations as well as manage them up and we ought to be doing it.

Dr. NELSON. May I continue along the lines that Lew Branscomb initiated and pick up a theme that he introduced earlier? I share Dr. Branscomb's notion that the appropriate answer to your question is no, we can't afford it and that yes, we do need to have better mechanisms that we have displayed ourselves as having recently to get more coordination in this area.

I take it that he would agree with me that you don't want anything in the way of tight central planning and that you want a considerable amount of pluralism on it, but you don't want to end up with the budgets that you have adding up to a certain total just by chance. That seems to be the way we are at the present time.

Given that these budgets are scattered around a large number of governmental departments and appropriately so because many of the major R&D investments are made by the government are quite closely associated with the missions of particular government agencies.

It seems to me and I know it seems to Lew Branscomb that if you are going to coordinate this and get some kind of overall planning and monitoring before the fact rather than after the fact, that

has to be a function located in the Executive Office of the President.

Over the years we have had various pieces of machinery there to try to accomplish this function and I share with Branscomb the notion that that machinery has for the most part not operated very well for a number of years.

To come to the particular concern of this committee, whereas when the Office of the President Science Advisor was formed many, many years ago, the issues that were of central concern then involved defense, they involved health, they involved the university budget and there wasn't much in the way of a consideration of a national technology policy.

At that time we could perhaps afford the luxury of an Office of the President's Science Advisor or an Office of Science and Technology Policy as it later became that stood, as it were, disjoined from the Council of Economic Advisors or the Office of the Management and Budget and those types of more economics oriented activities.

I don't think we can afford that at the present time given the way the issues are posing themselves now. I think it is quite interesting, however, that there was a period of time when there was a reasonably good dialogue between the Office of the President's Science Advisor and the Council of Economic Advisors. Jerry Wiesner and the late Walter Heller, in fact, had quite a bit of interaction and there was quite a bit of interaction among the staffs of those two offices then.

It is my understanding and I am not totally sure about this, but I have reason to believe that I am right that the connections between those parts of the Executive Office have not been anywhere near as close in the 25 years that have elapsed since that time, despite the fact that if anything, the policy issues ought to force people who are concerned with the making of economic policy to concern themselves more and more with the nation's technological strengths and enterprises and those who are concerned with the formulation of science and technology policy to be really concerned with how that links into economic policy more generally.

I think there is just an awful lot of thinking that needs to be done, as we get the next administration be it Republican or Democrat, in the way of the kind of machinery that is set up to deal with the questions you just asked, how do we deal with the question of laboratories that just happen to be there.

Is there some way that we can decide what is worthwhile spending on and what is not worthwhile spending on in the broad science and technology area? Is there some way that we can get in the Executive Office, if you are not going to get it there, you are not going to get it anywhere, a way of serious policy discussion about economic matters in which science and technology is treated as centrally concerned with that?

Mr. MacKay. Let me get the rest of the panel and I will come back, Dr. Branscomb.

Mr. Seifert. Just one observation. Clearly, if you don't have a policy, if you don't know where you are going, any road will get you there so we need a policy but we have to have the ability to carry it out.

One thing we have learned in industry is that we have had a lot of missions and policies and goals, but we didn't put something in place that had the ability to make it happen and carry out this policy and we got ourselves into trouble.

I don't know where it should be positioned but there needs to be some kind of an oversight board to see that it happens.

Mr. MacKay. That is fascinating. Mr. Sumney, do you care to comment?

Mr. Sumney. I still feel that the oversight board, and we keep coming around to this idea of some kind of a national oversight function that could be this advisory committee in the area of semiconductors and perhaps other areas of technology, that will indeed perhaps address the problems that you have enunciated.

I agree, my answer is no, we cannot afford to continue to go the way we are going.

Mr. MacKay. Dr. Branscomb.

Dr. Branscomb. I would just like to expand a trifle on my answer to your question about national laboratories. The problem in the national laboratories is not that we have too many people in them or they are too expensive or there is too much work going on, because we don't have enough highly skilled experienced American scientists and engineers to do the things that this country wants to do. It is getting worse every day with the universities having to go all over the world to fill the places in graduate schools in engineering because there aren't enough young Americans.

With the disaster that we have in public education at the K through 12 level, with the worst of that disaster in science and math, this problem is going to be a lot worse before it gets better. So the issue is not how to get rid of those unwanted scientists. The issue is how to match the capability to the nation's priorities.

I would like to suggest two things. One is something that this committee or perhaps its staff may already have done and that is to look into the question of a likely response of the Department of Energy to the amendments last October to the Stevenson-Wydler Act—the Technology Transfer Act of 1986—and the Executive Order that the President has issued requiring his agencies to pay attention.

That statute puts a very clear burden on the national laboratories to look at opportunities to make an economic contribution. I believe that if you go to the labs and ask them what they think about that, they say we take this statute very seriously and we are organizing to try to be faithful to it.

I believe if you go to the headquarters staff people in the agencyies that own the laboratories, you will find that they also will say.

Sure, we want to follow the bid of Congress and the Executive Order, but we are constrained by very clear specification of mission. The OMB looks over our shoulder to make sure that we don't do anything that is not in that mission. None of this stuff that is envisioned in the Stevenson-Wydler Act amendments lie within our mission, so I am sorry, but what we are going to do is going to be pretty trivial.

I would suggest that it comes back in that case to a central issue; namely, we have a Department of Energy in a world that needs reawakening to the fact that one day again we will have an energy crisis. Right now we don't seem to and therefore, the country is

very comfortable with a policy in which the Federal government is not doing very much technically about energy. That being the fact, it is no surprise that the tremendous laboratories that belong to this department don't have a lot to do. One day they probably will. In the meanwhile, there is the need to deploy that capability to the urgent. I will just close with one suggestion that always appealed to me. It is something that the French government either does or in any case did.

When Pierre Aigrain was the director general of research and technology in the French government, he had the authority to deploy a piece of one of the government laboratories on a problem that he concluded was urgent. There were funds available, allocated for his control to fund that work. The only requirement was that within three years of its initiation he had to have line item support from the legislative branch in order to continue, but he could start without asking for it.

It seems to me that we should have a strong OSTP with the authority to direct the Department of Energy to deploy ten percent of the budget of those national laboratories on problems that the National Science Advisor and the President agree is urgent. They should be able to deploy that manpower subject to coming back to the Congress to validate the project they have undertaken through the legislative process and appropriations process which, as you well know, takes a couple of years to get into and back out of again.

That would be just one mechanism for trying to address the issue you described.

Mr. MACKAY. Mr. Sumney and then Mr. Fawell. I have taken too much time and you are the next questioner.

Mr. SUMNEY. Just a few comments. I have been working with the National Academy of Sciences and Engineering in putting together a series of workshops. We have held two of them between the National Laboratories and the Semiconductor Industry and out of that we have come up with what you might call 20 mini-proposals that match indeed the capabilities and interests of the laboratories with the needs of the semiconductor industry.

The next step is what do we do with this and Lew Branscomb's ideas are, I think, exactly what we are going to try to do. It is going to have to encompass a change in mission by the Department of Energy to allow the laboratories to do this.

Our approach at the moment is to have Frank Press write a letter to the head of Energy recommending that this be done. We have also worked with OSTP in the formulation of these recommendations and also we are thinking about the recommendation he just mentioned that OSTP would direct such a move.

So we are taking it a step at a time but indeed, we are trying to match people's capabilities to the needs of the industry.

Mr. MACKAY. That's good. Mr. Fawell, excuse me, but Mr. Magazine indicated that he would like to comment.

Mr. MAGAZINE. Thank you, Mr. Chairman, I have just one question. There is a lot of legislation pending on the Hill. Senator Glenn has a bill to create essentially a civilian version of DARPA and an undersecretary for technology and I know Congressman

Ritter has a bill that is similar to Senator Hollings bill and so on and so forth.

There was a lot of discussion this morning about where to place certain functions. OSTP can act as a catalyst and can play some role in funding research. Dr. Branscomb mentioned that Commerce should take more technological responsibility and that there should be more work with industry.

But what are the three or four or five very specific roles, for instance, if there were to be a more central location to foster advancements in technology? If, for instance, just to take Commerce as an example, if Commerce were to be reorganized to pay more attention to the need to advancements in technology, what is that specific role or the specific functions?

Dr. BRANSCOMB. Is that question to me?

Mr. MAGAZINE. To whomever.

Dr. BRANSCOMB. My notion would be first of all to go back to the original Stevenson-Wydler Act which has been amended wisely to remove a lot of offensive language about civilian industrial technology but leaves the substance which is to recommend that the Commerce Department have the capability to finance joint work between industry and universities in downstream technologies.

I don't believe we should be dependent entirely on the National Science Foundation for supporting the intellectual work and the education base at the post graduate level for advanced manufacturing systems and processes and the like.

In fact, if you look very hard at the engineering research centers, they are all quite well chosen and doing excellent work but they are still not quite far down that downstream spectrum, as is needed.

Second, I would ask the Commerce Department to engage a major dialogue with manufacturing industry companies smaller than those that have corporate central research laboratories. Some of these companies relate well to universities where there is a local engineering college and they have a relationship, but by in large, the engineering colleges are staffed and funded for their research, working on problems of limited interest to these smaller companies.

I feel that if the Commerce Department began to build in the universities and non-profits and even profit-seeking enterprises the kind of engineering support capability the country needs, then you could imagine the states coming to the Federal government with a state technical services kind of activity and requesting technical expertise out of the Federal program for local industry development and job enhancement activities with the states.

The states is where the industrial strategy and partnership seems to be easiest to get going. The problem is that they don't have the intellectual resources to match it. So that would be my very short list.

I have one last point and it is in my testimony. Since the Department of Commerce does have a standards and trade responsibility, I would give them a mission to try to be more effective at persuading the entire government of the United States to look at standards from the point of view of the interests of both the users and the manufacturers in American commercial industry re ognizing that

they have a global market to work at and that gets at the question of commercial standards for worldwide markets.

I describe one such issue in my testimony relating to computer network protocols but there are many others.

Mr. MACKAY. Mr. Fawell.

Mr. FAWELL. Actually, I don't have a specific question. I apologize for not being here but I have been spending most of the morning in a Science and Tech hearing in regard to university facilities and Chairman Roe's sense of what we can do in regard to research facilities in our higher educational institutions both for graduate and post graduate and there was some discussions we had there in regard to the national labs.

In regard to commercialization I have a little bit of reticence in expressing myself in regard to what government can do. There are a number of things, of course, but I also have expressed myself before that I think that as far as our corporate culture is concerned, we seem to have a reticence for doing long term applied science research and looking so very definitely at the bottom line of profits and quarterly nature than are bigger than the preceding quarter and so forth and so on that kind of deny us the ability to take long term research in the applied sciences that previously was the American trademark.

We do it ironically in basic research but we do not do it in the commercializing of breakthroughs that we have. I know that Argonne National Lab back in my district, for instance, has a program which is doing a fairly good and perhaps is on the cutting edge of technology transfer, doing innovative work in that regard.

I also think our national labs can be utilized, I think, a lot more than they are in many areas, certainly in basic educational facilities, too. In the Chicago land area where we have some nine million people and based in the Chicago land area, we have Fermilab, we have Argonne, we have a high tech corridor, all of which can I think be used as far as higher educational R&D is concerned that has not been used.

So in connection with the statement made that our labs don't have a great deal to do at times, we have under utilized I think the facilities that we have there and the expertise that we have there. I know Leon Letterman is a great advocate of using the facilities at Fermi in Cook County and DuPage County and Willin County area for educational purposes.

I think simply that it is tough to bring educational entities, I think, especially those at highly well recognized institutions to agree to that while the lesser institutions are much more desirous of utilizing the national labs in that regard.

So I don't have a question, Mr. Chairman, but just comments that may or may not be relevant.

Mr. MACKAY. I think the comments are highly relevant. They are highly relevant to the whole question of the constraints, bureaucratic constraints, which are probably hindering the national labs and going forward and doing what they would like to do in technology transfer.

That is certainly one area that our report might be able to help with by highlighting that. Let me move on then to Mr. Brown.

Mr. BROWN. I think our conversation here has touched on many of the important issues in this area but we are a long ways from reaching a consensus on a set of prioritized goals to look for here.

On the question of the labs, of course, we had a presidential commission look at the labs not too many years ago and I think reached some of the same conclusions that you have expressed here. With regard to mission particularly, we have to look much more closely at the mission but nothing happened.

We had the Young Commission Report which recommended some reorganization including a Department of Science and Technology and nothing happened. You have all pointed to the fact that what we really need is strong policy leadership; at the time and we don't have it.

We also need some linking mechanisms of various kinds and we don't seem to have been able to create them. This committee generated the idea of the Office of Science and Technology and the Science Policy Advisor over ten years ago and several of you have commented that the situation has never been worse. So maybe we should have stayed away from it. [Laughter.]

We passed the Stevenson-Wydler Act and it went down the tubes. It has a lot of brilliant initiatives in it that should have been implemented. This is not a glowing account of the success of the Congress in being able to resolve problems.

The private sector, the corporate world, is driven by the realities that they exist in. When you have high interest rates, you have to get short term profits in order to defer the cost of your money. If you have a 12 percent real interest rate, you have to get return within a relatively short period. If you have a four percent real interest rate, you can go to a horizon that is far further out in terms of your investment decision.

I have come to the same conclusion that was expressed here that we don't have the proper linkages between economic and technological policy that would recognize this. I made a speech a few weeks ago and I will be glad to give you gentlemen copies in which I suggested that the Council of Economic Advisors and the OSTP and even the Federal Reserve Board worked much more closely together, that there be linkages there.

But I am reluctant to try and specify them because they probably wouldn't work. I really don't know how to address it. One possibility that I have suggested and I think I would like to see explored is that we use the huge investment resources of the public sector and I am talking about here the pension retirement reserves of state, local and other public jurisdictions and the Social Security System which will be generating surpluses that will run into the tens of billions of dollars per year over the next 25 to 35 years, that instead of being just passively used to reduce the Federal deficit in a rather fictitious way that those be aggressively managed to support long term research in a prudent way.

That, of course, will probably have to be coupled with steps to continue to bring the interest rates down which means cutting down Federal budget deficits and a few other things like that. These are all tightly linked if you are going to have a sound technology policy.

What we do here in the Congress is we kind of nibble around the fringes. We do some micro things which we hope will work out and a lot of the legislation that has been referred to here, the Hollings legislation, Glenn, Mr. Valentine, mine (I have a dozen ways to reorganize the technology function), most involve trying to create a more effective policy formulating process. I don't see that there is any consensus that we are going to achieve any of these micro steps.

I am reminded of the fate of Slade Gorton's bill in the last congress to set up an automated manufacturing capability which everybody says, "Gee, whiz, that is so simple, we ought to do it" and we passed it and sent it over and the President probably on the advice of the Science Advisor vetoed it.

So I am kind of stymied and my remarks are reflecting that more than anything else. But let me ask a specific question because I think Mr. Seifert, you brought up the matter of permanent investment package, the R&D tax credit. Although some question has been given to revamping the long term investment or capital gains situation, I have no evidence that either one of these has done a damn thing to improve our situation.

Have you any indications that it has? The amount of investment, the amount of savings, the amount of corporate investment in new plant and equipment, the amount of national savings have both gone down while we have had these things and the purpose was to have them go up, more investment, more savings.

Mr. SEIFERT. I couldn't agree with you more. The issue here is not particularly just the technology issue but it is the linkage to the economic system. I am not sure that I know the answer. I know that it did affect our investments, losing investment tax credits on capital and it affected our ability to modernize as fast as we had been.

I don't have a sense of a macro sense of the industry. We have also lost market share worldwide during the same period so I am not sure which is the cause and which is the effect.

Mr. BROWN. I don't want to stop the dynamic and positive approach that we are taking here but I am rather pessimistic myself about how we are going to grapple with these problems until we are really hurting.

When we are really hurting and we may be getting awfully close to that, I think we are going to do some of the things that the Japanese did or some of the other countries because you need a compelling drive and we are too fat in this country.

Dr. BRANSCOMB. Mr. Brown, let me just observe that however discouraged you and I and others might be that the country is not responding in some of the ways it should, you and your colleagues have made a real contribution to the first half of the problem, which is to get people to understand what the issue is.

The second half is to get them motivated to act on it and I agree with you, that motivation comes from necessity not from somebody's intellectual exposition of how to optimize a governmental system.

But I really do believe that unless the debate that your task force is leading to understand the strengths and weaknesses of our industrial and technological system is well understood by a lot

more Americans then when the motivation comes we will do the wrong thing.

We will do more of what we did before rather than the new things that need to be done. So I am all for trying to get these issues as well understood as possible against the day when somebody is motivated to act and then maybe they will do the right thing.

Mr. BROWN. There is a time and place for all things and it may be that it will come before too long and that our more modest goal ought to be to be prepared with a better understanding and a kit of possible solutions that could be available for deployment relatively quickly.

Mr. MACKAY. Mr. Fawell.

Mr. FAWELL. Along the line my colleague from California has indicated that it may be agony which will cause us to take a long look at what according to several articles that I have read define as the corporate ultimate roadblock of American business and I alluded to that just briefly, that the fixation upon the quarterly returns and the understandable concern that corporations have in regard to corporate raiders, if you don't have short term get rich quick treatment of stockholders, et cetera, and all of this according to a number of articles that I have read, and I am not expert on it, is that as a result American business which has always been short in cooperative ventures because that is not our culture, it is to do it alone and free enterprise and entrepreneurial spirit which is the opposite of what Japan has, that they are very able to cooperate in the R&D and then break ranks when it comes to having perfected the product and compete.

But the agony that we are going through and the adjustments perhaps can be traceable to the culture of the American entrepreneurial spirit. I made the suggestion at one of these gatherings that in the area of super conductivity, for instance, I was just repeating, I believe, the statement made by Mr. Laudice, the former chairman of AT&T, that a cooperative venture, for instance, with the Japanese in the area of superconductivity could be considered. There is enough profit to go around and indeed of the entire world for the product that may come from this is great, at least it is something that might be considered.

We, I think, basically have problems within our country as far as our major corporations are concerned even with all of the help we have given for relief through the anti-trust laws, et cetera, et cetera, et cetera. We still are not used to cooperative ventures and I think we must look long and hard again at what is called the corporate cultural roadblock of American business being able and willing to adjust as much as they should because in the final analysis, the real running halfbacks here are going to have to be the corporations of America.

I am not sure if I have made myself clear or not.

Mr. BROWN. Mr. Chairman.

Mr. MACKAY. Yes, Mr. Brown.

Mr. BROWN. I have a brief opening statement which I was reluctant to offer because it dealt with a subject of the relationship between science and technology and economics and I didn't know whether it was appropriate or not but since we have been discuss-

ing that, I ask unanimous consent to insert my opening statement in the record.

Mr. MACKAY. Excellent. It will be inserted at the beginning as if that is what we intended to discuss all along. [Laughter.]

Mr. BROWN. May I further reverse the situation a little bit in light of the new format that the Chair has so successfully produced here and ask if each of you gentlemen will accept a copy of my speech of two weeks ago and make comments on it which contains some of the hair-brained ideas that I have hinted at.

Mr. MACKAY. Would you also let other members of the panel have that speech? That would be excellent.

Mr. BROWN. Well, that is going too far, Mr. Chairman. [Laughter.]

Mr. MACKAY. Then in finalizing this revolutionary idea that there has to be better ways to talk to each other than the traditional committee hearing structure, I have committed to each of you that you would have a chance to kind of sum up now that we have all talked about kind of the evolving questions and answers and I would like to honor that commitment and start with Dr. Nelson and go down the panel again. Dr. Nelson.

Dr. NELSON. I have found it an interesting morning. I think the theme that was introduced after the fact by Mr. Brown in the first thing that we did in the morning of the connections among science, technology and the economy has been the hallmark of much of the discussion.

I share also Dr. Brown's sense of frustration that there has been a lot of talk about somehow doing this better, and a lot of ideas have been presented as to how to go about doing this better, and yet nothing has happened. This is probably the way I end up reflecting on the morning as well as him.

Dr. BRANSCOMB. My suggestion is probably unnecessary because you have probably already executed it and that is that the task force engage in some thoughtful and informal discussion with not only Mr. Block but the National Science Board's chairman about the willingness of the NSF not only to carry forward their proper piece of this responsibility, recognizing that the President has challenged them to grow their responsibility some and he has promised to try to help them grow the budget to match, with your gentlemen's help.

But I believe that it is going to be very important for the NSF and the NSB in particular to participate in the national discussion of what are the other activities, the other investments in technical capacity, infrastructure, if you like, that are not only appropriate but necessary for the Federal government to make. These activities might lie beyond what the Science Board and the director think is appropriate or practical for NSF to do. But the NSF should engage in the discussion of how such things might be done.

It is a bit of a stretch for them to discuss matters that lie outside their own domain but it is not contrary to the challenge that is in the statute for which you gentlemen are responsible.

I guess what I am trying to say by way of summary and in response to some extent to Mr. Brown's discouraging assessment is that we have some very important assets in the governmental in-

stitutions. At any given time, some are strong and some are less strong.

I think we have a tremendous asset in the National Science Foundation and a kind of new look is going on there. I would urge that they be encouraged to reach beyond their traditional, largely self-imposed limitations in the view of their scope and mission. If they do not stretch their mission, at least stretch their willingness to discuss their role in the context of the total government challenge which is the subject, I think, of this task force and no doubt of Mr. Brown's wise remarks which I look forward to reading.

Mr. MacKay. Thank you, very much. Mr. Sumney.

Mr. Sumney. I would like to focus my comments, I guess, starting out with the comment about corporate awareness. I think if you go back and look at the semiconductor industry which is one that arose out of very serious competition amongst each other and in 1977 began to recognize that indeed perhaps it was going to be more important to be able to compete worldwide rather than internally, they started the Semiconductor Industry Association shortly thereafter. After that introspection, the Semiconductor Industry Association has gone on to start the Semiconductor Research Corporation which I think has successfully carried out the mission that was initially established for it and intends to continue working on that mission and the enlarged role that SEMATECH will allow it to execute.

Then the Semiconductor Industry Association has come up with the SEMATECH proposal which is a continuing evolving approach to keep moving the line between what we consider to be proprietary knowledge and what we consider to be public knowledge recognizing in a very thoughtful way that that line can probably be moved away from proprietary knowledge more into the public sector so that we can make more efficient use of much knowledge that is generated from various sources, whether it be national laboratories or industrial laboratories or what have you.

So I would like to say that there is a certain degree of industrial awareness. I think, that exists, albeit even when this industry started it was strongly competitive. I think they have recognized that they have to cooperate and I think that cooperation, if you look at something like SEMATECH, they recognize that it has to involve many sectors of our economy. The national laboratories, NSF, DOD, all of those people are participating in the workshops that we are holding right now.

However, we feel that this latest initiative, the scope of it is large enough and the problem is broad enough that government support in this R&D effort is essential to the success of it or even the initiation of it and without that, it simply will not be able to solve the problem that it has defined which I think we all agree is a serious problem. So I would like to close with that.

Mr. MacKay. Thank you. Mr. Seifert.

Mr. Seifert. Yes. I think American industry has changed in the last decade. Most of us are getting more into sharing agreements. Semiconductor research and SEMATECH and things like that did come out of industry getting together.

Many of us have relationships with firms in other countries and we are sharing technology much more than we ever did. So I think our culture is changing.

The one problem that we seem to have and I resonate with Mr. Brown's remarks is this linkage between our economic system and our technology. It doesn't seem to link up. It is the same as it has been for a long time and it is a different situation in other countries and I would like to see the government work on that.

Mr. MacKay. I would like to thank our panel and I would say to you very sincerely, we understand the commitment of time that you gave to prepare for this hearing and to come here. This has been extraordinarily helpful to us. As I said to you informally before the hearing, we reserve the right to come back and ask you for more advice as time goes on. Thank you very much. We are adjourned.

[Whereupon, at 12:02 p.m., the task force recessed to reconvene at the call of the Chair.]

O

5-014 (88)